

## APPENDIX A

The following table summarizes examples of microfluidic components and structures that can be made available in a library for design capture.

Component/ Structure	Brief Description	Reference(s)	Figure Number(s)
ON/OFF Switches	An ON/OFF switch is open in the ON state allowing fluid flow therethrough and is closed in the OFF state to prevent fluid flow therethrough.		
	Pressure-actuated, normally open switch	Present Application  60/282,253	2A-3  7A-7E 8
	Pressure-actuated, normally closed switch	60/282,253	9A-9D
	Vacuum-actuated, normally closed switch	60/282,253	10 & 15A- 15J
	Inverted pyramid pressure amplification switch	60/282,253	39A-39D 40-41
	T-switch	Present Application	13A
Valves	Valves are provided for directing fluid flow.		
	Side-actuated valve	PCT/US00/ 17740	48A-48B
	Unidirectional valve for permitting fluid flow in one direction therethrough	60/282,253	20A-B 21 22 23
Interconnect Bridges	Interconnect bridge having a control channel with tapered element for bridging a fluid channel	Present Application	17B
Vias	Vias provided in one channel for bridging another channel.	Present Application	18B
Tapers	Fluidic taper for facilitating connection between a larger channel and a small channel	Present Application	28
Switchable Flow Arrays	Switchable flow array including fluid passages that can be selectively directed to flow in two perpendicular directions	PCT/US00/ 17740	31A-31D

Component/ Structure	Brief Description	Reference(s)	Figure Number(s)
Multiplexer	Multiplexer having multiplexed channel flow controllers for directing fluid flow into one or more of a plurality of synthesis channels or chambers in which solid phase synthesis may be performed	PCT/US00/17740	33
Gates or Gate Structures	Fluidic logical gates can be used to perform Boolean functions.		
	Inverter for inverting an input to produce an output	60/282,253	12A
	OR gate	60/282,253	12C
	NOR gate	60/282,253	12E
	AND gate	60/282,253	12G
	NAND gate	Present Application	5A
	Latch/Flip-flop	Present Application	6A 6B
		60/282,253	33
	D-latch	Present Application	7A
Amplifiers	Fluidic pressure amplifier for amplifying pressure	60/282,253	3-4B
Pumps	Fluidic pumps are used for pumping fluid.		
	Pump operating by compression and bending of fluid chamber	60/282,253	17A-B
	Peristaltic pump with multiple control lines for pumping	PCT/US00/17740	24A-24B
	Rotary pump/mixer for mixing and incubating solutions	Present Application	21
Capacitors & Reservoirs	A capacitor or reservoir can be used for storing and releasing pressure.		
	Single-chamber high-pressure reservoir	60/282,253	24
	Two-chamber capacitor	60/282,253	28-29B
	Single-chamber vacuum reservoir	60/282,253	32
Pressure Sources	High pressure source for applying high pressure fluid to load devices	60/282,253	26
Generators	High pressure generator having stages for multiplying output pressure	60/282,253	27
Vacuum Sources	Vacuum source for driving vacuum-actuated devices	60/282,253	30

Component/ Structure	Brief Description	Reference(s)	Figure Number(s)
Fluid Chambers	Selectively addressable reaction chambers provided along flow lines and in an array for selectively directing fluid flow into one or more of the reaction chambers	PCT/US00/ 17740	28A-30
Switching Regulators	Switching regulator for performing analog functions	60/282,253	34
Sorting Devices	Sorting device for cell sorting and DNA sizing	PCT/US00/ 17740  Present Application	36  27-28
Separation Devices	Separation device for perform separation of materials	PCT/US00/ 17740	43
Cell Pen Structures	Cell pen array for storing materials within a selected, addressable position for ready access	PCT/US00/ 17740	44A-44D
Cell Cage Structures	Cell cage with pillars that permit opening of cage for transfer of cells	PCT/US00/ 17740	45A-45B
Cell Grinder Structures	Cell grinder with interdigitated posts that can be closed to crush material therebetween	PCT/US00/ 17740	46A-46B
Pressure Oscillators	Pressure oscillator for generating pressure oscillation	PCT/US00/ 17740	47
Mirror Array Structures	With appropriate control circuitry, a microfluidic structure having a light-reflecting membrane may be employed as a digital or analog mirror array.	PCT/US00/ 17740	38
Refractive Devices	Refractive device having elastomeric material capable of transmitting incident light	PCT/US00/ 17740	39 40 41

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## APPENDIX B



## General Icon Properties

Two distinguishable colors representing channels on different layers. Red in this case representing the control channel and blue the fluidic channel. There are typically two ports on each of the channels represented by white circles, or dots, sometimes outlined with black circles. Some of the icons will only have one color representing a channel only present on one layer and others will have two colors representing components composed of multiple channels on multiple layers.

### Orientation

The orientation of the components in the icons does not represent its final placement in the microfluidic design. Once the component is placed, it can be rotated with freedom to any degree (0 – 360).

## Valve



### Description:

The valve icon represents the basic switching element and consists of channels of different widths and lengths with connection points, or ports.

## T- Switch



### Description:

The T-Switch represents a basic component that is used to direct the incoming flow in the fluidic channel to none or one of two channels based on the state of the control channels. The channels for both the fluidic and control layer can be of different widths and lengths with connection points, or ports.

## Control Tapers



Control Taper

### Description:

The Control Taper is a basic component that allows a connection from a larger control channel to a smaller control channel or visa versa. The ends of the tapers can be of different widths based on the needed geometries of what needs to be connected.

## Fluid Taper



Fluid Taper

### Description:

The Fluid Taper is a basic component that allows a connection from a larger fluid channel to a smaller fluid channel or visa versa. The ends of the tapers can be of different widths based on the needed geometries of what needs to be connected.

## Peristaltic Pump



Pump

### Description:

The Peristaltic Pump is a basic component that allows the active control of fluid in either direction. The actual channels, both fluidic and control, can be of different widths based on the geometries required for proper operation.

## Pump and Dampener



Pump+Dampener

### Description:

The Peristaltic Pump and Dampener is a basic component that allows the active control of fluid in either direction and includes dampening channels to smoothen the flow of fluid.

The actual channels, both fluidic and control, can be of different widths based on the geometries required for proper operation.

## Multiplexers



### Description:

The Multiplexers are basic component that allows the active control of fluid in 8 or 16 fluid channels based on a binary application of control signals to the control channels. The actual channels, both fluidic and control, can be of different widths based on the geometries required for proper operation. In general, these icons can be extended to cover N fluid lines controlled by  $2\log N$  control lines.

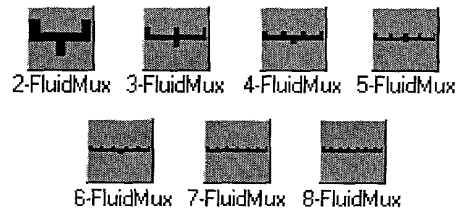
## Rotary Mixers



### Description:

The Rotary Mixers are basic components and come in different configurations based on the application needs. The Rotary Mixer comes in three basic variations of the fluid input and output ports: 2 fluid input/output (I/O), 3 fluid I/O, and 4 fluid I/O. The Rotary Mixer Sq has a different topology which allows “tiling” of the mixers and comes in two basic variations of the fluid input and output ports: 2 fluid input/output (I/O) and 3 fluid I/O. The actual channels, both fluidic and control, can be of different widths based on the geometries required for proper operation.

## Fluid Mux Connectors



The Fluid Mux Connectors are basic components that are sized and positioned to work the Multiplexer and Channel Array Components. These icons represent the “mux” connections from 2 through 8 array or multiplexer outputs or inputs.

Fluid Mux Connector

## Bridges

The purpose of the Bridge component is to allow control lines to cross over fluid lines without stopping the flow of the fluid line below it. This feature enables the user to design the chip with more complexity and greater density. Note: The flow line is not completely unaffected because the membrane of the bridge component will deflect when the control line is actuated. The amount of deflection will depend upon the amount of pressure that is applied to the control line.

## Channel Arrays

The channel array provides a set of individually addressable flow lines. The number of control lines is equal to the number of flow lines for this component. The flow of the liquid within the array can be controlled in any fashion by actuating the necessary control lines.

## Control Components

The Control components allow the Control lines to be arranged in the configurations required by the user. The dimensions of these components have been established using the minimum recommended lengths for the individual components.

## Dampeners

The Dampener elements are used provide smoother flow of pumped liquid. The membrane of the Dampener element will deflect and absorb the energy caused by the closing of the valves of the peristaltic pump.

## Fluid Components

The Fluid components allow the Fluid lines to be arranged in the configurations required by the user. The dimensions of these components have been established using the minimum recommended lengths for the individual components.

## Fluid Mux Connectors

The Fluid Mux Connectors enable the user to interface the flow lines of the Multiplexer and Channel arrays to other components. They have been designed to match the flow line spacing for these components.

## Mixers

The Mixers are used to mix two or more different liquids within a closed loop. Mixing is accomplished by pumping the liquid around the closed loop. Parabolic flow of the liquid within the loop allows for fast and efficient mixing. The different Mixer orientations allow the user to arrange the mixers in various configurations (arrays, etc.) depending upon requirements.

## Tapers

The taper element is required when varying the width of the control lines or the fluid lines. This requirement is necessary because of the manufacturing process involved in making the molds for the chips.

## Multiplexers

The Multiplexer element allows the user to flow liquid in any single flow line at a given time using a predetermined control scheme. The number of control lines required for a given multiplexer can be calculated using the equation  $2(\log_2 N)$ , where




































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The Pump element is a peristaltic pump which is composed of three individual valves. The liquid within the flow lines are pumped by sequentially actuating the individual valves. The Pump can be used with or without the Dampener element.

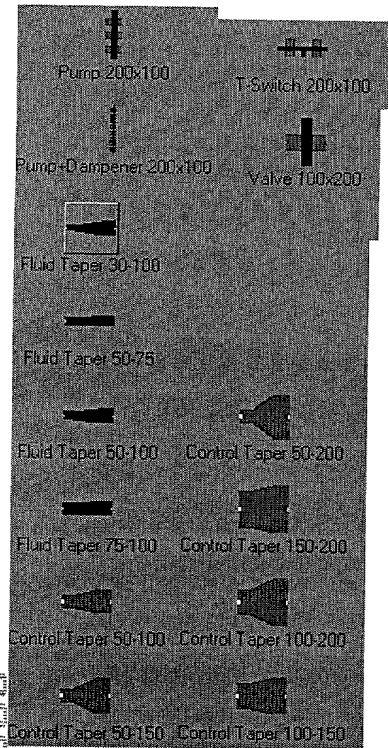
The T-Switch element allows the user to control the input of two flow lines into a single flow line or vice versa. The valve elements can be used to turn the flow of each input on and off so that the desired liquid runs through the single line or the valves can be used to separate the flow from a single line to two lines.

The valve element is used to turn the liquid flow on and off. This is controlled by providing sufficient air pressure to cause the membrane to deflect and pinch off the flow line.



					
FluidX 30	Fluid Elbow 100	2-FluidMux 100	3000-Rotary Mixer Sq 200x100-3	1000-Rotary Mixer 200x100	16-Mux 200x100
					
FluidX 50	Fluid Elbow 30	3-FluidMux 100	4000-Rotary Mixer 200x100	1000-Rotary Mixer 200x100-4	8-Mux 200x100
					
FluidX 75	Fluid Elbow 50	4-FluidMux 100	4000-Rotary Mixer 200x100-4	2000-Rotary Mixer 200x100	
					
Fluid T Junction 75	Fluid Elbow 75	5-FluidMux 100	4000-Rotary Mixer Sq 200x100-3	2000-Rotary Mixer 200x100-4	
					
Fluid T Junction 30	FluidX 100	6-FluidMux 100	2000-Rotary Mixer Sq 200x100-2	2000-Rotary Mixer Sq 200x100-3	
					
Fluid T Junction 50		7-FluidMux 100	3000-Rotary Mixer Sq 200x100-2	3000-Rotary Mixer 200x100	
					
Fluid T Junction 100		8-FluidMux 100	4000-Rotary Mixer Sq 200x100-2	3000-Rotary Mixer 200x100-4	





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## APPENDIX C

# FluidArchitect™ User's Guide/Reference Manual

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## **Preface**

### **What is a Microfluidic Chip?**

Fluidigm's technology is the product of highly successful basic research. The Company's technology was developed by researchers at the California Institute of Technology who sought to create assays based on the interactions of individual molecules, cells, viruses and proteins. These assays, and the fluidic technology that enables them, proved overwhelmingly advantageous over their macroscopic counterparts and yielded functionality unavailable until now. These capabilities are the result of breakthroughs in active fluidic devices, surface chemistry, material science, and optical instrumentation. Fluidigm's microfluidic chips provide order of magnitude sensitivity increases and unparalleled flexibility by actively manipulating femtoliters of fluid.

### **What is FluidArchitect?**

FluidArchitect is the design automation applications portion of a revolutionary microfluidics platform that Fluidigm has built and continues to develop. This platform allows the user the ability to design customized microfluidic chips from Fluidigm's library of basic building blocks components with built in rule checking and submit the design for fabrication.

The design automation tool guides the user through the design process setup process and allows the user the ability to simply drag, drop, click, and connect components to form a customized microfluidic chip. User's who are familiar with Microsoft Windows applications will be able to use the FluidArchitect.

### **FluidArchitect User Requirements**

Users of the FluidArchitect design automation application should have the following requirements:

- A good understanding and previous experience with microfluidics
- Experience with computer aided design applications



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The following are the system requirements for installing FluidArchitect onto a PC.

- ## Installing FluidArchitect

FluidArchitect is delivered as an installation package to be executed on the target PC it is to be installed onto. The installation package will automatically guide you through the installation process step by step. All files and libraries will be installed into a directory that can be specified by you.

Once you have successfully installed the program onto your computer you will need to request a license to unlock the FluidArchitect application in order to use it. The unlock code that will be generated is specifically for the computer the application is installed on. Follow the steps outlined below to request a license for your copy of FluidArchitect.

1. Start the FluidArchitect installer.
2. The InstallShield application will now walk you through the steps of selecting a target directory and installing all the necessary files and directories onto your computer.
3. After finishing installation, go to *Programs > Fluid Architect > Fluid Architect* under the *Start* menu on your computers desktop to start the FluidArchitect application.



4. Figure 1 shows the dialog box will come up on the first time FluidArchitect is executed. The Site code shown in red is specific to the computer in which the FluidArchitect is being installed.

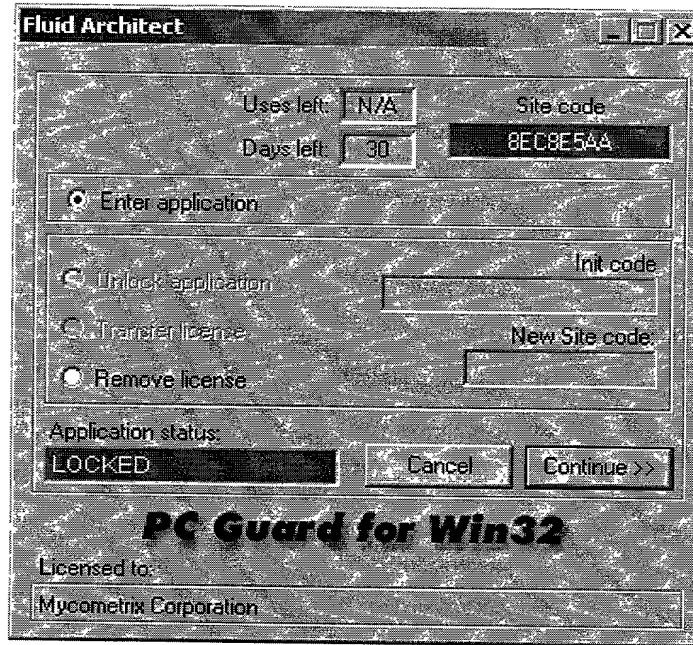


Figure 1 – License Manager

5. Select the Site code and copy the code. Paste the code into an email along with the following information:
- Contact Name
  - Company
  - Address
  - Phone Number
  - Fax Number (optional)
  - Email Address
6. Email the information to [license@fluidigm.com](mailto:license@fluidigm.com). A license will be generated and emailed back to you typically within 24 hours.

## Licensing FluidArchitect

After you have received an email containing your Initialization code, follow the steps below to license FluidArchitect.

1. You will receive a 16 digit alphanumeric string based on the Site code sent in your email.
2. Enter the 16 digit alphanumeric string EXACTLY as it is shown in the email including the “-” character which separates the strings. See Figure 2. In this case the Init code of *TEST-12345678-LOCK* was entered.
3. Click the *Continue >>* button to complete the licensing process.

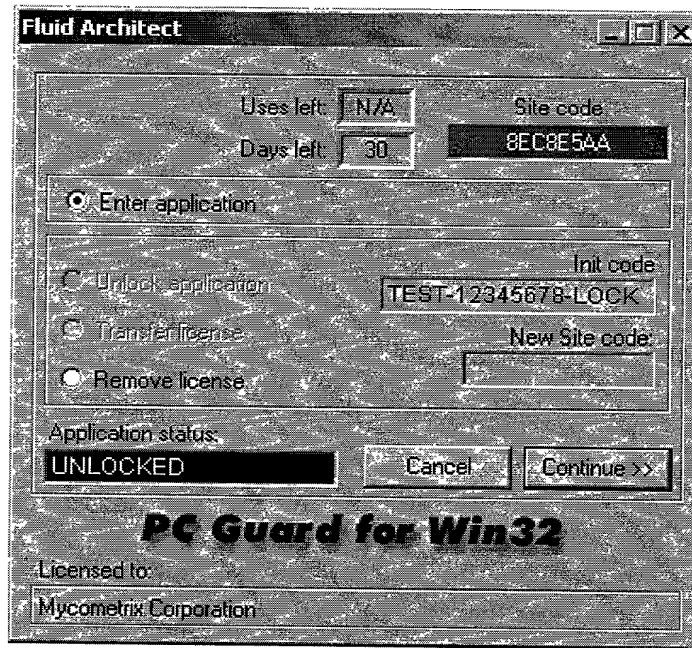


Figure 2 – Dialog to Enter the Init Code

4. After successful entry of the Init code the application is ready for use.

## Trouble Shooting Licensing

Check the following items to resolve licensing issues:

- Check the Site code sent to Fluidigm for Init code generation. If the Site code does not match what is displayed in the dialog box then the Init code will not work. Resend the correct Site code for a new Init code following the directions given in the previous sections.
- FluidArchitect has been successfully installed and removed from the computer you are trying to reinstall onto. Once the application has been removed from a computer it is not possible to reinstall and use the old license. A new license must be generated but the existing license from your current working installation must be removed first and verified before a new Init code can be sent.

## Chapter 2 – Design Process

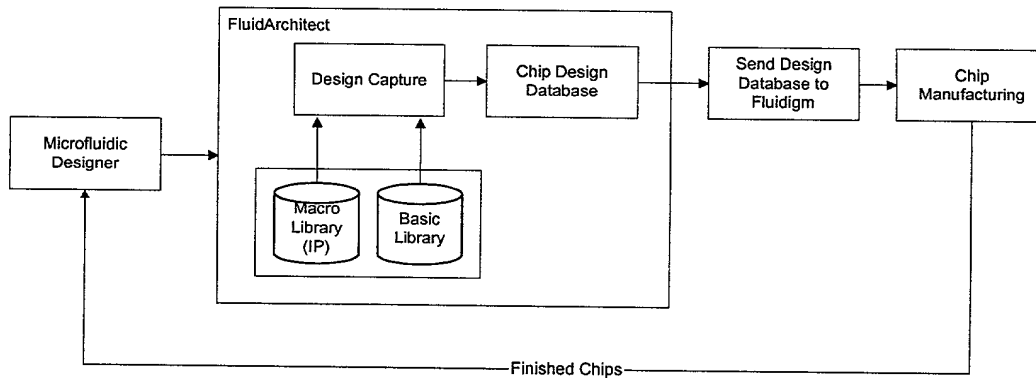


Figure 3 – Microfluidic Chip Design Process with FluidArchitect

### Design Flow Process

The design process for designing and building a microfluidic chip is described in Figure 1. Application specific microfluidic chips can be created using the library components provided by Fluidigm. FluidArchitect allows you to capture your design in a simple drag and drop, point and click design environment. Once the design has been completed it is sent to Fluidigm for fabrication. Fabricated devices are sent back to the microfluidic designer for use.

### Application Interface

FluidArchitect's interface contains the entire environment in which a design will be started and completed for submission to Fluidigm for fabrication.

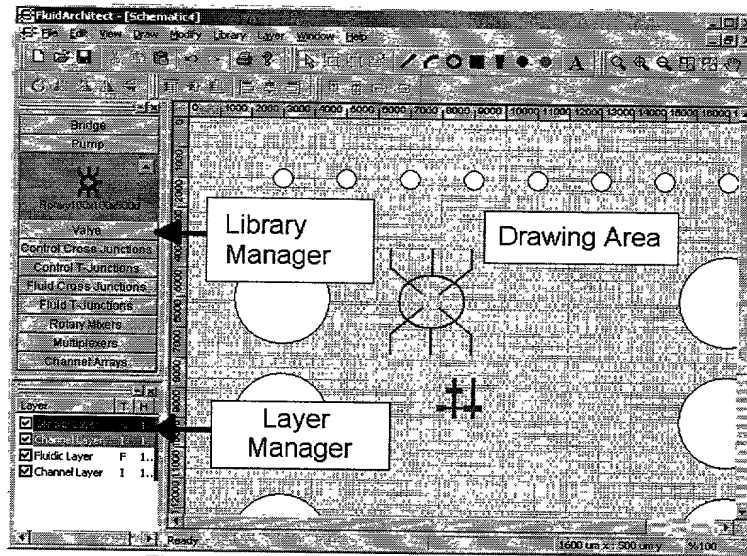


Figure 4 – FluidArchitect's User Interface

The user interface has three primary components: *Library Manager*, *Layer Manager*, and *Drawing Area* (see Figure 4).

#### *Library Manager*

The component libraries come predefined and are installed with the FluidArchitect application. The library components are tested and approved for use in the microfluidic chip making process. These libraries will be updated with new components as they are approved from Fluidigm for use. The component library will be delivered as part of a new release or

Parameter	Value	Unit
Initial concentration	0.1	mol/L
Temperature	25	°C
Time	0, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768, 65536, 131072, 262144, 524288, 1048576, 2097152, 4194304, 8388608, 16777216, 33554432, 67108864, 134217728, 268435456, 536870912, 1073741824, 2147483648, 4294967296, 8589934592, 17179869184, 34359738368, 68719476736, 137438953472, 274877906944, 549755813888, 1099511627776, 2199023255552, 4398046511104, 8796093022208, 17592186044416, 35184372088832, 70368744177664, 140737488355328, 281474976710656, 562949953421312, 1125899906842624, 2251799813685248, 4503599627370496, 9007199254740992, 18014398509481984, 36028797018963968, 72057594037927936, 144115188075855872, 288230376151711744, 576460752303423488, 1152921504606846976, 2305843009213693952, 4611686018427387904, 9223372036854775808, 18446744073709551616, 36893488147419103232, 73786976294838206464, 147573952589676412928, 295147905179352825856, 590295810358705651712, 1180591620717411303424, 2361183241434822606848, 4722366482869645213696, 9444732965739290427392, 18889465931478580854784, 37778931862957161709568, 75557863725914323419136, 151115727451828646838272, 302231454903657293676544, 604462909807314587353088, 1208925819614629174706176, 2417851639229258349412352, 4835703278458516698824704, 9671406556917033397649408, 19342813113834066795298816, 38685626227668133590597632, 77371252455336267181195264, 154742504910672534362390528, 309485009821345068724781056, 618970019642690137449562112, 1237940039285380274899124224, 2475880078570760549798248448, 4951760157141521099596496896, 9903520314283042199192993792, 19807040628566084398385987584, 39614081257132168796771975168, 79228162514264337593543950336, 158456325028528675187087900672, 316912650057057350374175801344, 633825300114114700748351602688, 1267650600228229401496703205376, 2535301200456458802993406410752, 5070602400912917605986812821504, 10141204801825835211973625643008, 20282409603651670423947251286016, 40564819207303340847894502572032, 81129638414606681695789005144064, 162259276829213363391578010288128, 324518553658426726783156020576256, 649037107316853453566312041152512, 1298074214633706907132624082305024, 2596148429267413814265248164610048, 5192296858534827628530496329220096, 10384593717069655257060992658440192, 20769187434139310514121985316880384, 41538374868278621028243970633760768, 83076749736557242056487941267521536, 166153499473114484112975882535043072, 332306998946228968225951765070086144, 664613997892457936451903530140172288, 1329227995784915872903807060280344576, 2658455991569831745807614120560689152, 5316911983139663491615228241121378304, 10633823966279326983230456482242756608, 21267647932558653966460912964485513216, 42535295865117307932921825928971026432, 85070591730234615865843651857942052864, 170141183460469231731687303715884105728, 340282366920938463463374607431768211456, 680564733841876926926749214863536422912, 1361129467683753853853498429727072845824, 2722258935367507707706996859454145691648, 5444517870735015415413993718908291383296, 10889035741470030830827987437816582766592, 21778071482940061661655974875633165533184, 43556142965880123323311949751266331066368, 87112285931760246646623899502532662132736, 174224571863520493293247799005065324265472, 348449143727040986586495598010130648530944, 696898287454081973172991196020261297061888, 1393796574908163946345982392040522594123776, 2787593149816327892691964784081045188247552, 5575186299632655785383929568162090376495104, 11150372599265311570767859136324180752990208, 22300745198530623141535718272648361505980416, 44601490397061246283071436545296723011960832, 89202980794122492566142873090593446023921664, 178405961588244985132285746181186892047843328, 356811923176489970264571492362373784095686656, 713623846352979940529142984724747568191373312, 1427247692705959881058285969449495136382746624, 2854495385411919762116571938898990272765493248, 5708990770823839524233143877797980545530986496, 11417981541647679048466287755595961091061972992, 228359630832953580969325755111919221821239	

Once the design has been completed and verified free of errors it can be submitted to Fluidigm for fabrication. The design database can be found in the directory that the design was created in. The file extension of the design database is \*.mdx. This file can be sent to [manufacturing@fluidigm.com](mailto:manufacturing@fluidigm.com) along with your contact information. A representative from Fluidigm will contact you regarding the details of your order for fabrication.

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## Chapter 3 – Design Editor Reference

### Introduction

The goal of the design editor is to help you design effectively and as efficiently as possible. The libraries that are built into FluidArchitect represent microfluidic structures that are approved for implementation in Fluidigm's processes. "Channel" drawing tools are provided to connect the microfluidic structures available from the libraries. The sections below will describe the design editor in detail.

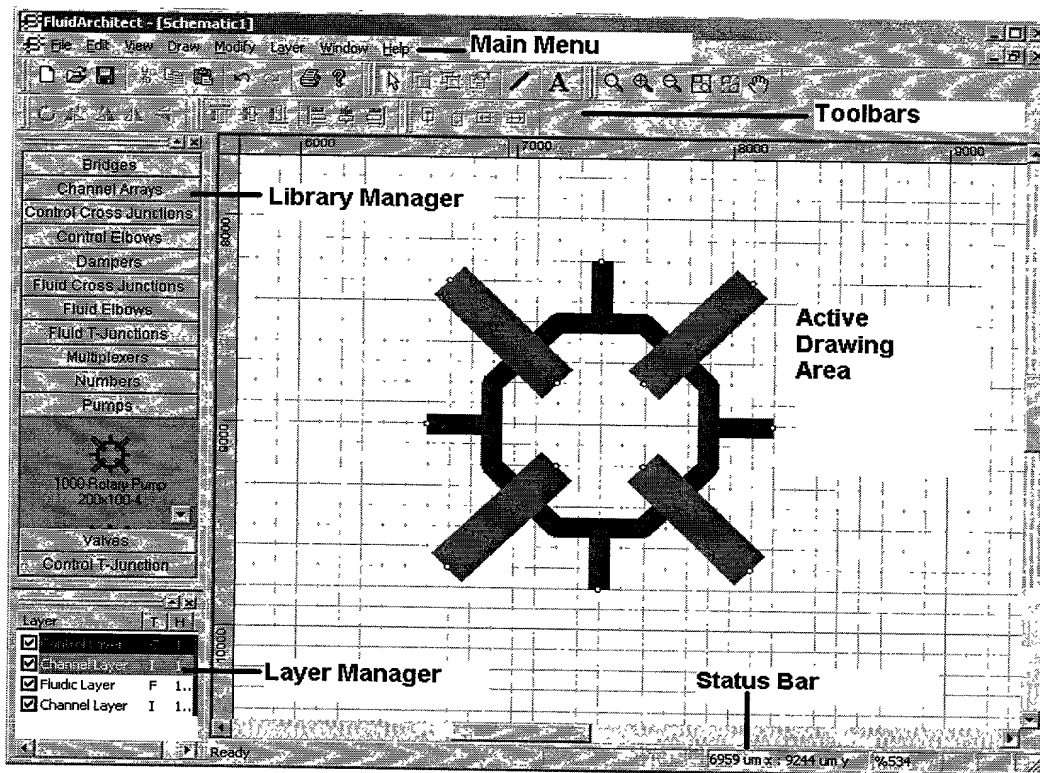


Figure 5 – FluidArchitect Main User Interface (Main Menu, Toolbars, Library Manager, Layer Manager, and Active Drawing Area)

### Menus

#### Main Menu

The main menu is composed of nine menu groups which group related operations and commands for the application.

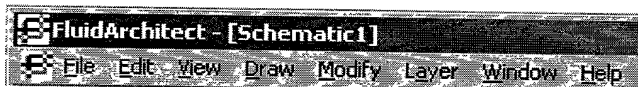


Figure 6 – Main Menu Bar

[illegible]

**File > Open...**

**File > Close**

**File > Save**

**File > Save As...**

*File > Page Setup*

*File > Print*

*File > Print Preview*

13



## Edit Menu

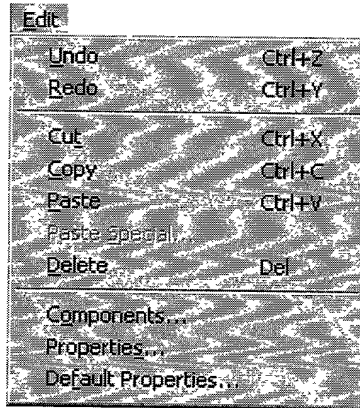


Figure 8 – Edit Menu Commands

### Edit > Undo

The *Undo* command will undo the last command you executed on the active design project.

### Edit > Redo

The *Redo* command will reverse the last command *Undo* command you executed on the active design project.

### Edit > Cut

The *Cut* command cuts and pastes all selected components in the drawing area into the Clipboard.

### Edit > Copy

The *Copy* command copies and pastes all selected components in the drawing area into the Clipboard.

### Edit > Paste

The *Paste* command will paste the contents of the Clipboard into the drawing area. Only objects using the *Cut* or *Copy* command can be pasted from the Clipboard.

### Edit > Paste Special

Not Currently Defined.

### Edit > Delete

The *Delete* command is used to delete any selected object in the active drawing area.

### Edit > Components

The *Components* command will bring up the Components dialog box. The dialog box, Figure 5, will show all of the components that are currently placed into the active drawing area.

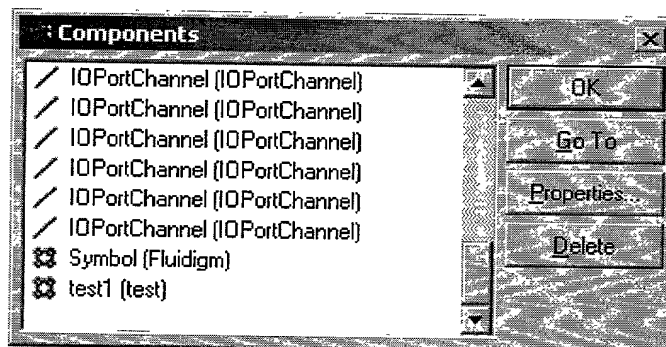




Figure 9 – Component Dialog Box

Additional commands available from this dialog box are:

- *OK* – Closes the dialog box
- *Go To* – Not currently implemented
- *Properties* – Opens the Properties dialog sheet for the component
- *Delete* – Not currently implemented

### **Edit > Default Properties**

The *Default Properties* command will bring up the Properties dialog box for the entire design. The dialog box, Figure 6, will show all of the default settings for the design

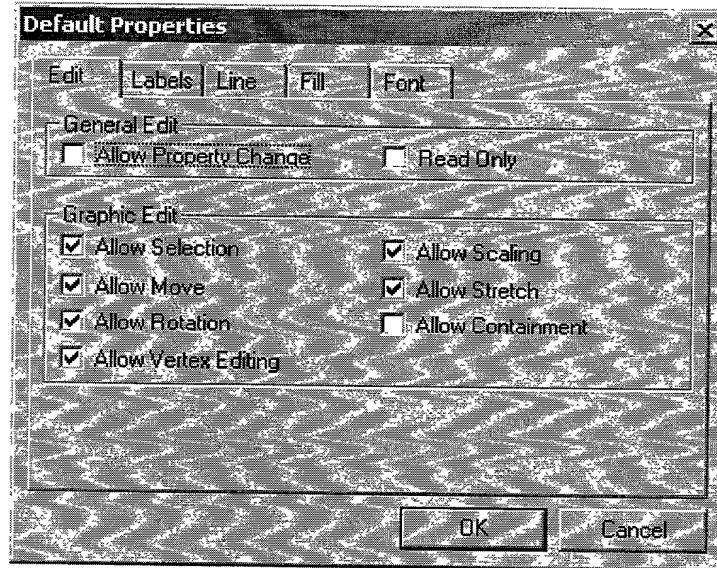


Figure 10 – Default Properties Dialog Box

- *OK* – Closes the dialog box and save any changes
- *Cancel* – Closes the dialog box and discards changes
- *Edit tab* – Not currently implemented
- *Labels* – Sets the label orientation for components
- *Line* – Not currently implemented
- *Fill* – Not currently implemented
- *Font* – Sets the fonts options for the labels

## View Menu

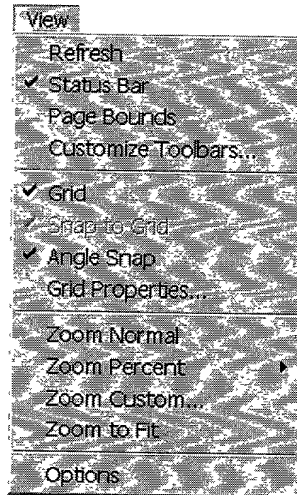


Figure 11 – View Menu Commands

### View > Refresh

The *Refresh* command will redraw the active drawing area. Sometimes the drawing area may not refresh completely during editing of the design leaving screen artifacts. The *Refresh* command can be used to redraw the screen to eliminate the artifacts. Note that the artifacts will not be saved into the design.

### View > Status Bar

The *Status Bar* command can be used to display or remove the status bar in the lower right corner of the application. The Status Bar, Figure 12, shows the selected component, the screen location of the cursor, and the percent zoomed.

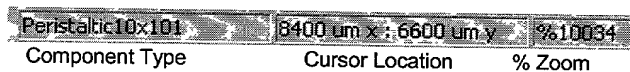


Figure 12 – Status Bar

### View > Page Bounds

The *Page Bounds* not currently implemented.

### View > Customize Toolbars...

The *Customize Toolbars...* allow you to show or hide the toolbar tool bars in the application window directly under the Main Menu bar. Figure 13 shows the dialog box that appears when this command is selected. All of the toolbars, including the Main Menu bar, can be displayed or hidden based on settings made through this dialog box with the Toolbars tab selected.

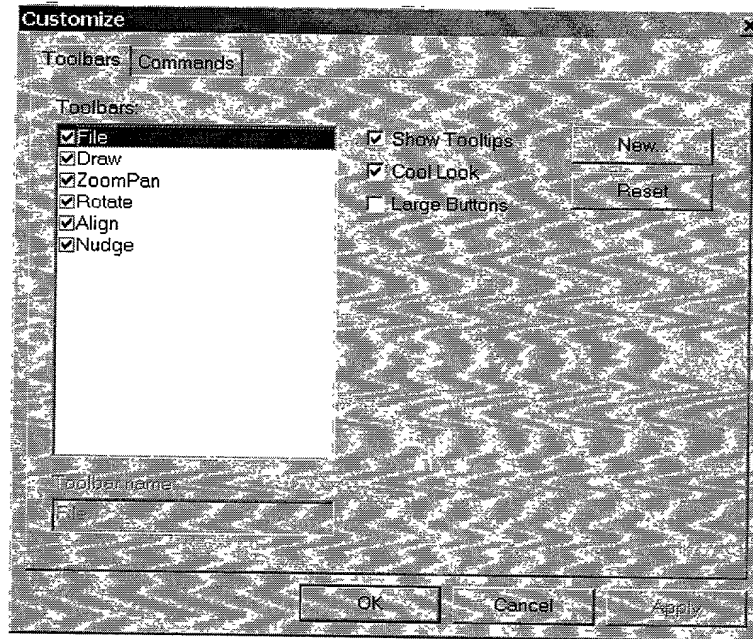


Figure 13 – Customize Toolbars Dialog Box with Toolbars tab selected

The toolbars can be customized by dragging and dropping commands icons from the dialog box directly into the existing toolbars present in the application. Figure 14 shows the “Buttons” or commands that can be left click and dragged to the toolbars.

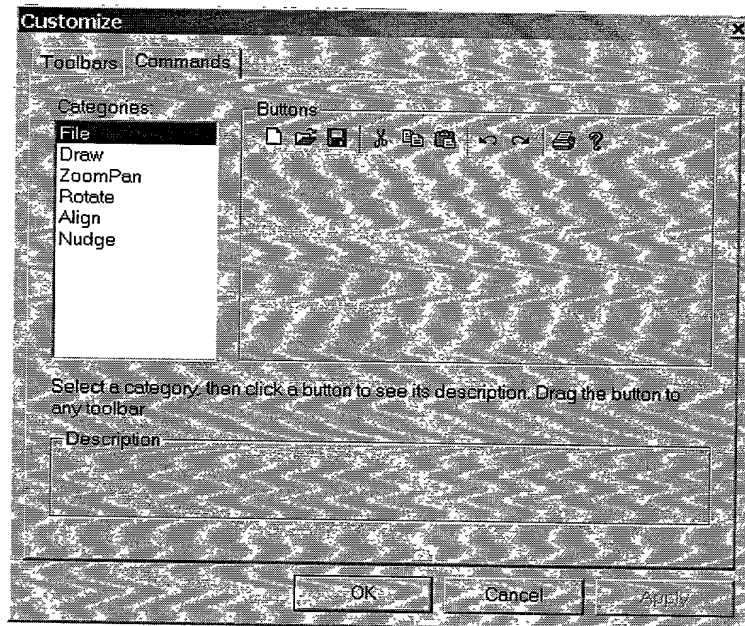


Figure 14 – Customized Toolbars Dialog Box with Commands tab selected

#### View > Grid

The *Grid* command enables or disables the grid to be displayed in the active drawing area.

### View > Grid Properties...

The *Grid Properties...* command will bring up the dialog box, Figure 15. The Grid dialog box allows you to set the grid color and the intervals at which the grid is rendered and also to enable or disable the grid from the drawing area.

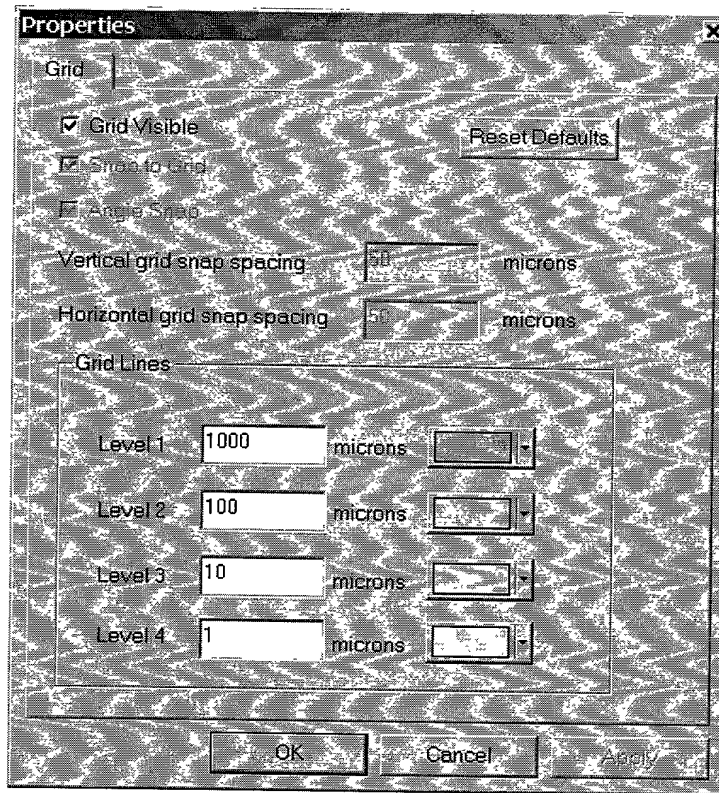


Figure 15 – Grid Properties Dialog Box

### View > Zoom Normal

The *Zoom Normal* command will zoom the view of the active drawing area to view the entire chip.

### View > Zoom Percent

The *Zoom Percent* command allows you to select 50%, 75%, 100%, and 200% zoom of the active drawing area.

### View > Zoom Custom...

The *Zoom Custom...* command allows you to select 50%, 75%, 100%, and 200% from the drop down box and you can also enter in your own zoom factor of the active drawing area.

### View > Zoom Fit

The *Zoom Fit* command will zoom the view of the active drawing area to view the entire chip.

### View > Options

The *Options* command will bring up the *Grid* and *Library* dialog box, Figure 16. The Grid properties are the same as those in the *View > Grid Properties...*

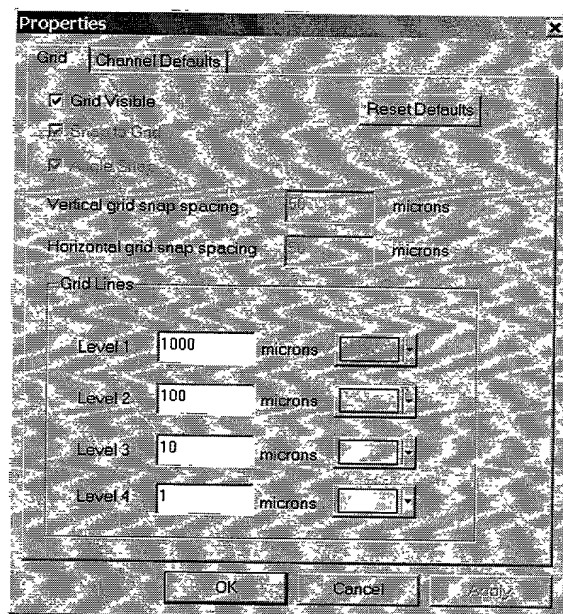


Figure 16 – Grid and Channel Defaults Dialog Box

The Channel Defaults allow you to set the default channel widths for the fluidic and the control layer channels that are drawn to interconnect the library components. Figure 17 shows the dialog box with the Channel Defaults tab selected.

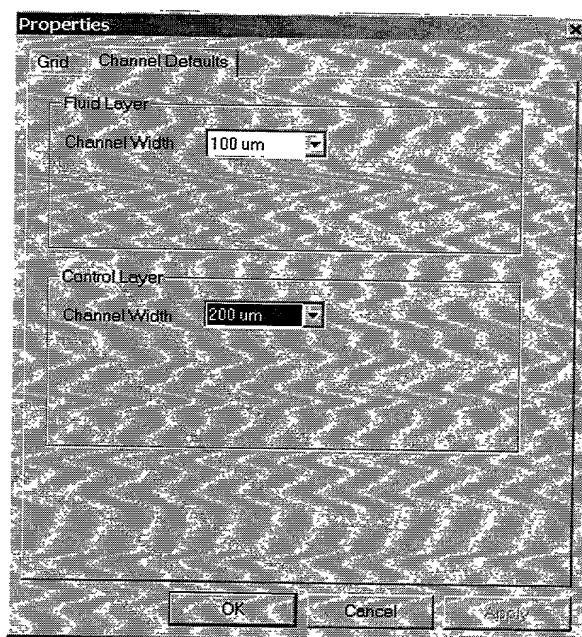


Figure 17 – Channel Defaults Selection Dialog Box

The drop down boxes allows you to set the default width of the channel that you draw on both the fluidic and control layer. Keep in mind that any drawn channel's width can be changed using the Property sheet for each channel.

## Draw Menu



Figure 18 – Draw Dialog Box

### Draw > Channel

The *Channel* command places the mode of the active drawing area into drawing channels. A drawn channel will be to the layer that is currently “Active”. A layer can be set active in two methods: enabling the layer to be active through the *Library Manager*, Figure 12, or through a right mouse click while in the active drawing area with the *Select* tool selected. Select the *Layers* command to set the desired layer, Figure 19.

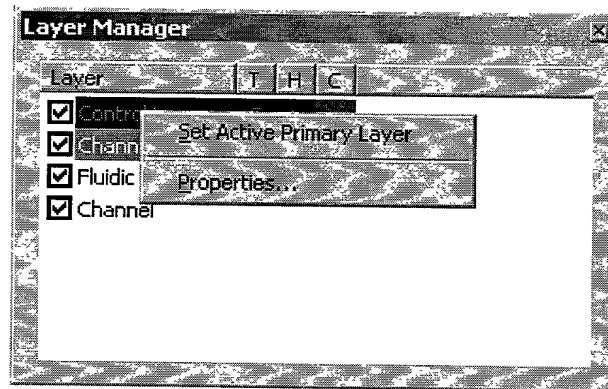


Figure 19 – Library Manager Window

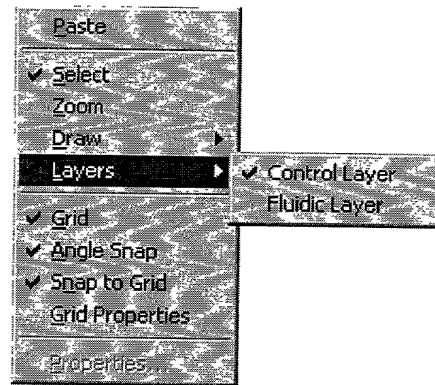


Figure 20 – Right Click Pop Up Menu in Drawing Area

## Modify Menu

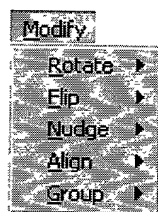


Figure 21 – Modify Menu Commands



The *Down* command allows you to move the selected object(s) down one micron in the active drawing area. Holding the Shift key while executing this command will move the object 5 microns.

*Modify > Nudge > Up*

The *Up* command allows you to move the selected object(s) up one micron in the active drawing area. Holding the Shift key while executing this command will move the object 5 microns.

*Modify > Nudge > Left*

The *Left* command allows you to move the selected object(s) left one micron in the active drawing area. Holding the Shift key while executing this command will move the object 5 microns.

*Modify > Nudge > Right*

The *Right* command allows you to move the selected object(s) right one micron in the active drawing area. Holding the Shift key while executing this command will move the object 5 microns.

## Modify > Align

The *Align* command contains a submenu of commands, Figure 25, which can be performed on a selected object(s) in the active drawing area.

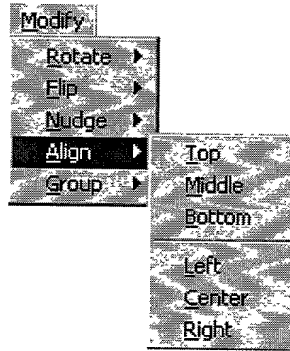


Figure 25 – Align Submenu Commands

*Modify > Align > Top*

The *Top* command allows you to select a group of objects in the active drawing area and have the top of the objects aligned together.

*Modify > Align > Middle*

The *Middle* command allows you to select a group of objects in the active drawing area and have all of the objects aligned to horizontal middle.

*Modify > Align > Bottom*

The *Bottom* command allows you to select a group of objects in the active drawing area and have the bottom of the objects aligned together.

*Modify > Align > Left*

The *Left* command allows you to select a group of objects in the active drawing area and have all of the objects aligned to the left.

*Modify > Align > Center*

The *Center* command allows you to select a group of objects in the active drawing area and have all of the objects aligned to vertical center.



*Modify > Align > Right*

The *Right* command allows you to select a group of objects in the active drawing area and have all of the objects aligned to the right.

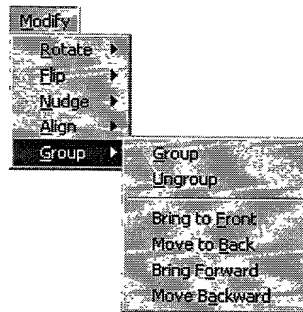


Figure 26 – Group Submenu Commands

*Modify > Group*

The *Group* command allows you to select a group of objects in the active drawing area and group the objects into a single entity or the ability to select a grouped object and ungroup them into their original components.

*Modify > Group > Group*

The *Group* command allows you to select a group of objects in the active drawing area and group the objects into a single entity.

*Modify > Group > Ungroup*

The *Group* command allows you to select a grouped object in the active drawing area and ungroup the objects back to their stand alone state.

*Modify > Group > Bring to Front*

Not Currently Implemented

*Modify > Group > Move to Back*

Not Currently Implemented

*Modify > Group > Bring Forward*

Not Currently Implemented

*Modify > Group > Move Backward*

Not Currently Implemented

## Layer Menu



Figure 27 – Layer Menu Command

### Layer Manager

The *Layer Manager* command brings up the Layer Manager dialog box as shown in Figure 27.

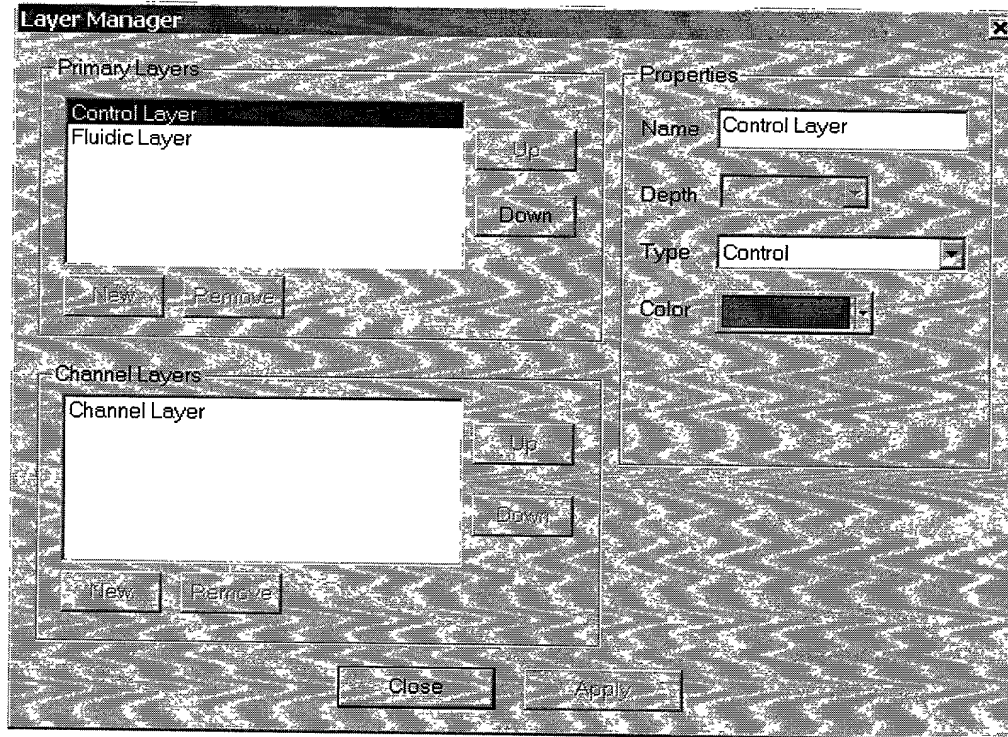


Figure 28 – Layer Manager Dialog

### Primary Layers

The *Primary Layers* section of the dialog box shown in Figure 28 shows the total number of layers present in the design. Currently it is not possible to change the *Name* nor the *Depth* of these primary layers. You can change the color of the layers in the *Properties* section of the dialog box once the primary layer is selected. Click on the *Apply* button after any changes are made to save the changes.

### Channel Layers

The *Channel Layers* section of the dialog box shown in Figure 28 shows the total number of channel depths available in one primary layer. Currently this is set to one channel depth per primary layer. You can change the name of the channel layer by left clicking on the layer name to select it in the Channel Layers section of the dialog and then entering in a new name in the *Properties* section. Click on the *Apply* button after any changes are made to save the changes. Also note that the channel depth is shown for the layer once it has been selected.













[illegible]

## ***File Toolbar***



Figure 31 – File Toolbar







<b>Toolbar Command</b>	<b>Command</b>
	<i>New</i> – Opening a new design database and starts the Design Wizard to walk you through the setup.
	<i>Open</i> – Opens an existing design database.
	<i>Save</i> – Saves the design database of the active drawing window.
	<i>Cut</i> – Cuts any selected object(s) in the active drawing window and saves it to the system clipboard.
	<i>Copy</i> – Copies any selected object(s) in the active drawing window and saves it to the system clipboard.
	<i>Paste</i> – Pastes a item from the system clipboard into the active drawing window. Note: It is not advisable to paste objects other than those cut or copied from the FluidArchitect application.
	<i>Undo</i> – Undoes the last command performed. Repeated undo can be performed.
	<i>Redo</i> – Redoes the last undo command.
	<i>Print</i> – Prints a scaled copy of the design to the printer. The scaled design will be scaled to best fit the standard size printer page.
	<i>Help</i> – Brings up the “About FluidArchitect” dialog with the release information.

### Table 1 – File Toolbar Commands

## Drawing Toolbar



Figure 32 – Drawing Toolbar

Toolbar Command	Command
	<i>Select</i> – Opening a new design database and starts the Design Wizard to walk you through the setup.
	<i>Group</i> – Groups selected objects in the active drawing window.
	<i>Ungroup</i> – Ungroups objects that were previously grouped together using the <i>Group</i> command.
	<i>Properties</i> – Displays the properties of a selected component/channel in the active drawing window.
	<i>Draw Channel</i> – Places the mode of the active drawing window in the mode of drawing channels. Once this command is selected the tool remains in this mode until it is unselected through selecting another command. Right clicking twice in the active drawing area will switch the mode of the drawing area back to the <i>Select</i> mode.
	<i>Text</i> – The text tool can be used to place notes in the active drawing window. Note: Text is NOT rendered onto the final output of the chip design.



### Zoom Pan Toolbar

Table 2 – File Toolbar Commands



Figure 32 – Zoom Pan Toolbar







Toolbar Command	Command
	<i>Zoom</i> – This command places the active drawing window in the zoom mode and the cursor becomes a magnifying glass icon. Click and hold the left mouse button and drag to form a rectangle over the area you wish to zoom into.
	<i>Zoom in 25%</i> – This command zooms in the active drawing area in by 25%.
	<i>Zoom out 25%</i> – This command zooms out the active drawing area by 25%.
	<i>Zoom to Fit</i> – This command zooms the active drawing area to fit the entire chip to the display area.
	<i>Zoom to Selection</i> – This command zooms the active drawing area to fit the selected objects to the display area.
	<i>Pan</i> – This command places the active drawing window in the pan mode and the cursor becomes a hand icon. Click and hold the left mouse button to pan the active drawing area in the direction desired.

Table 3 – Zoom Pan Toolbar Commands

### Rotate Toolbar



Figure 33 – Rotate Toolbar






Toolbar Command	Command
	<i>Rotate</i> – The command is used to freely rotate a selected object in the active drawing area. Note: This command should be used carefully as freely rotating objects can cause the connecting point/ports to become “off-grid” making it impossible to connect other components and channels to it.
	<i>Rotate Left</i> – This command rotates a selected object in the active drawing area 90 degrees counter clockwise.
	<i>Rotate Right</i> – This command rotates a selected object in the active drawing area 90 degrees clockwise.
	<i>Flip Vertical</i> – This command flips a selected object in the active drawing about its vertical center axis.
	<i>Flip Horizontal</i> – This command flips a selected object in the active drawing about its horizontal center axis.

Table 4 – Rotate Toolbar Commands

### Align Toolbar



Figure 34 – Align Toolbar



## Library Manager

The Library Manager is shown in Figure 36. This window of the FluidArchitect application contains the library components that are available for your design.

Use of the Library Manager is simple and straightforward. To select the library desired, simply left click on the title of the library and the components will be displayed. If more than one component is present in the library use the up or down button to scroll through them.

Once the proper component is found, left click the mouse button and hold and drag the component into the active drawing area and release the button to place the component.

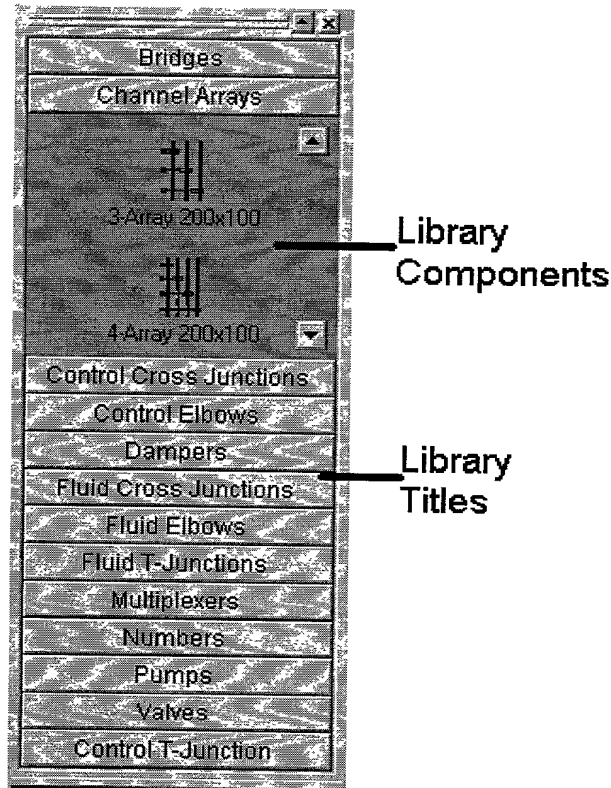


Figure 36 - Library Manager Window

Please refer to the **Fluidigm Databook** for a list of available library components along with their description and specifications.

### Library Component Characteristics

A library component is typically composed of channels. Some components have channels only on one layer while some have channels on both layers. Figure 37 shows a microfluidic valve from the Valves library.

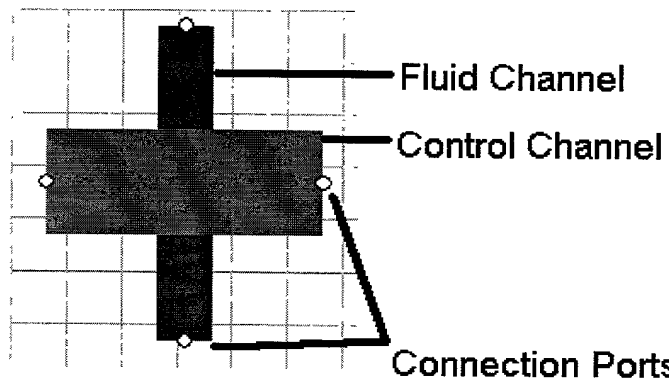


Figure 37 – Typical Library Component and Characteristics

The blue line represents a fluid channel present on the *Fluidic* layer while the red line represents a channel on the *Control* layer. The connection ports are points where connections from other components or drawn channels can legally be connected to the component.

**Note:** Channel or component connections to connection ports of components MUST be members of the same layer.



## Layer Manager

The Layer Manager serves to indicate the coloring of the layers as well as the different channel heights that are available in the particular layer. Currently only two layers are available at this time. The Layer Manager can be used to select the “Active” layer such that any drawn channels are added to that layer, change the coloring of the layer, and display or hide a layer from the active drawing area.

Figure 38 shows the Layer Manager window and the highlights the information available from the Layer Manager window.

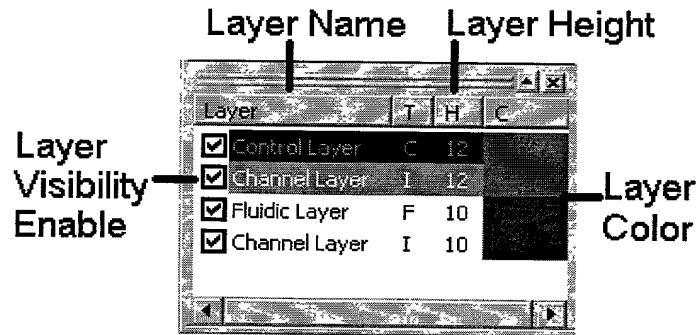


Figure 38 – Layer Manager

### Layer Color

The default layer color is blue for the fluidic layer and red for the control layer. These colors can be changed to suit your preference.

### Setting the Active Primary Layer

As mentioned above, the “Active Primary Layer” can be set through the Library Manager. Figure 39 shows the pop up after selecting the *Control* or *Fluidic* layer by left clicking to select it in the Layer Manager. Once selected, right clicking will bring up a pop up dialog box allowing you the ability to set the layer to be active.

Setting the layer to be active enables the following:

- Drawing of channels onto that layer.
- Selecting channels or components that are on that layer and performing actions on those selected.
- Changing the color of the layer. Any new color selected will replace the existing color for all components and channels in that layer.

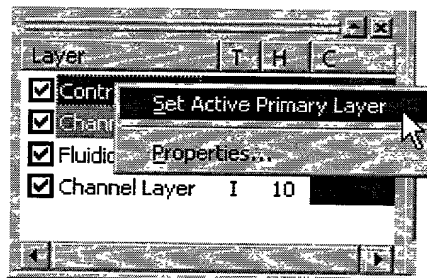


Figure 39 – Setting the Active Primary Layer

## Active Drawing Area

The active drawing area is where components from the library are placed and connected together using the *Drawing* tools.

### Rulers and Grid

The rulers displayed in the active drawing window displays the absolute location from (0,0) which represents the top left hand corner of the chip template. Figure 40 shows an example of the rulers and the grid from the active drawing window.

The lower right hand corner represents the (20000, 20000) position. These position numbers also translate into real measures as they are represented in microns. The grid color and the interval of grid lines can be changed using the *Grid Properties* command from the *View* menu.

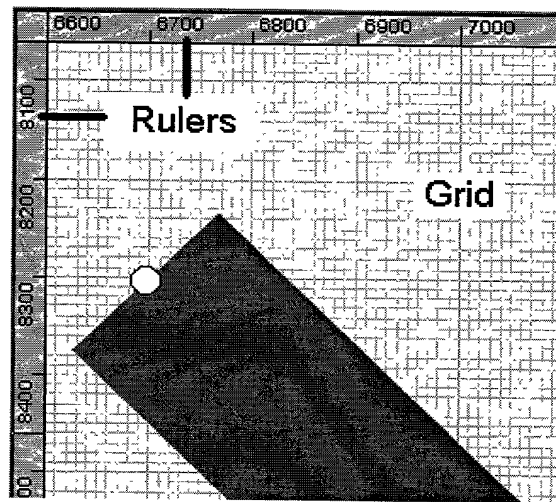


Figure 40 – Ruler and Grid from Active Drawing Window

### Pop Up Menus

The active drawing area has right click pop up menus based on the function that is currently selected. There are two different pop up menus, one for the Select tool and the other for a selected component.

Select tool (  ) enabled Pop Up Menu



commands available. The function descriptions can be found in the Main Menu or Toolbar commands with the exception of the *Properties...* command

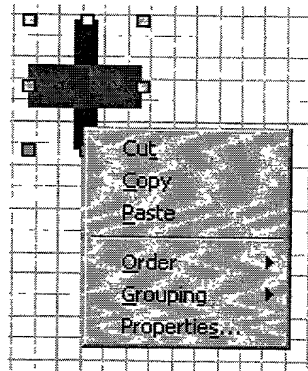


Figure 43 – Selected Component Pop Up Menu

Figure 44 shows a channel selected and the pop up menu with its available commands. Notice here the addition of the *Channel Widths* command. The Channel Widths command allows quick modifications of the drawn channels so that matching to connected components or channels is easily facilitated. Figure X shows an example where a channel drawn at 50  $\mu\text{m}$  needs to be connected to a pump control element that is 200  $\mu\text{m}$  in width.

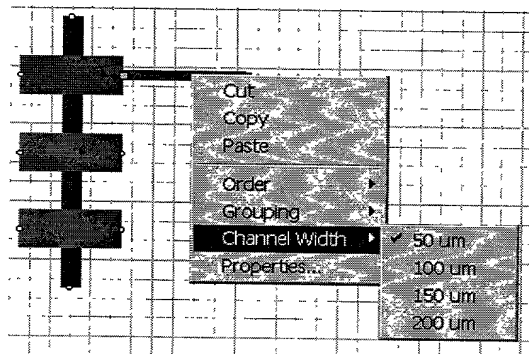


Figure 44 – Selected Channel Pop Up Menu

## Status Bar

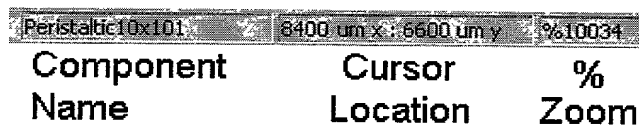
The Status Bar has two modes. One mode is when the drawing area is in the *Select* mode and the other is in the channel drawing mode.

### Select Mode

In the *Select* mode the status bar contains the following information:

- Left Status Box: Component Name
- Center Status Box: Absolute Cursor Location (in microns)
- Right Status Box: Percentage Zoomed In

Figure 45 shows the Status Bar while in the select mode.

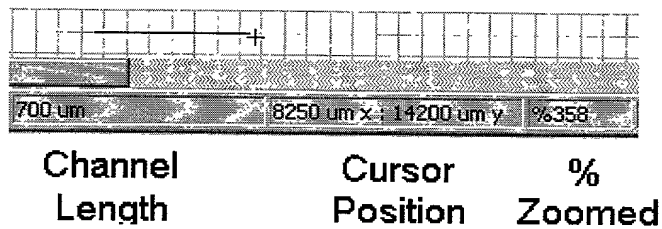


## Drawing Mode

In the *Drawing* mode the status bar contains the following information:

- Left Status Box: Length of channel drawn (in microns)
- Center Status Box: Absolute Cursor Location (in microns)
- Right Status Box: Percentage Zoomed In

Figure 46 shows the Status Bar while in the select mode. Notice as you start drawing the channel the status bar is updated with the length of the channel drawn.



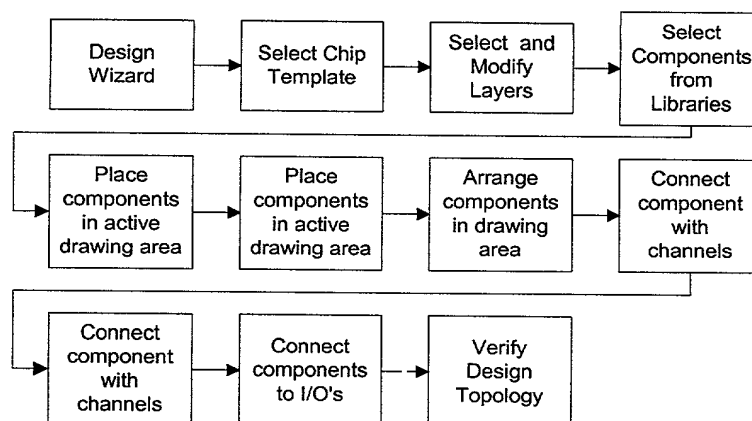
[illegible]

Figure 47 – Design Creation Block Diagram

## General Rules For Design Implementation

FluidArchitect was built with many design rules that are implemented directly into the various parts of the design system. As such, FluidArchitect applies those design rules to your design as you are placing and connecting the components from the libraries in the drawing area. The following are general rules to keep in mind and will help lead to a successful design implementation.

- **Only library components delivered by Fluidigm can be used in a design.**
- **Do not overlap components.** All components should be connected to other channels or other components via port connections. (see *Connecting Components and Channels*)
- **Do not overlap channels.** Channels on the same layer or channels on different layers cannot be overlapped. User drawn channels must be used to connect other channels and components.
- **Only connect channels on the same layer and of the same width.** The set of components provided can be interconnected using the Channel tool. Depending on the layer, Fluidic or Control, a choice of channel widths is provided. Be sure to select the proper width for your connection.
- **Use common sense for placement of components.** Some components require more connections than others. Plan your design carefully so that you are not route restricted to where your components cannot be connected to due to other connection requirements.

## Design Wizard

The Design Wizard walks you through the setup of the design and will allow you to set up the following details of your design:

- **Design Directory**  
The design database will be kept into the directory that you specify in this wizard screen, see Figure 48. You can change the final directory using the *Save* or *Save As...* command under the *File* menu.



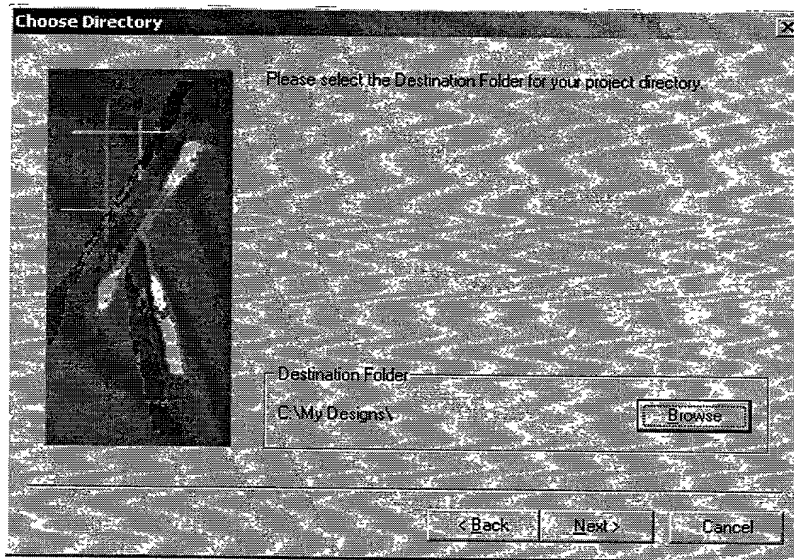


Figure 48 – Design Directory Selection Wizard Screen

- **Chip Template Selection**  
The appropriate chip template can be selected from this wizard screen, see Figure 49. As you click the < Previous and Next > buttons a thumbnail of the template will appear. Notice that the solid black circles represent where inputs and outputs will be placed and the number of each particular input and output size is shown to the right of the thumbnails. Currently, once you have selected a template it is not possible to change during your design process

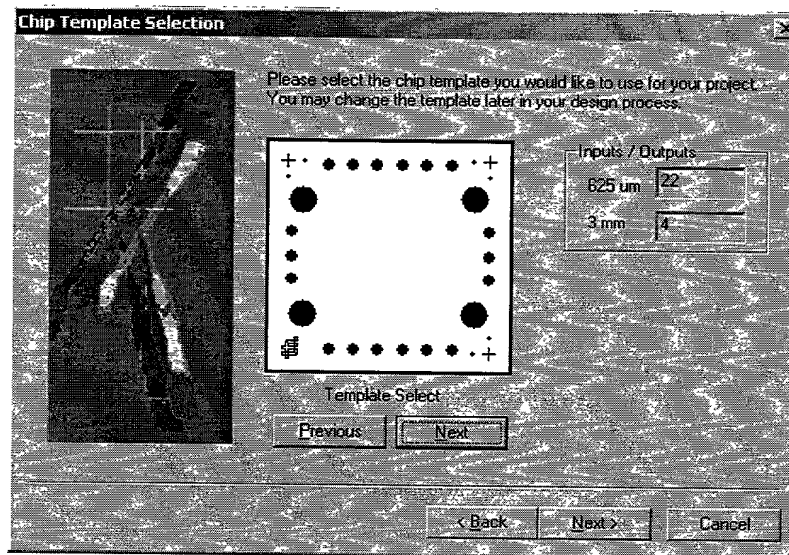


Figure 49 – Chip Template Selection Wizard Screen

- **Layer Selection**  
The layer selection screen, Figure 50, shows the number of layers that are available for use. The default is a pair of layers composed of the *Control Layer* and the *Fluidic Layer*. You can choose to deselect the layer by left clicking on the check box next to the layer name and the layer will be removed from the design. Note that after removal of this layer, active components will not be possible.

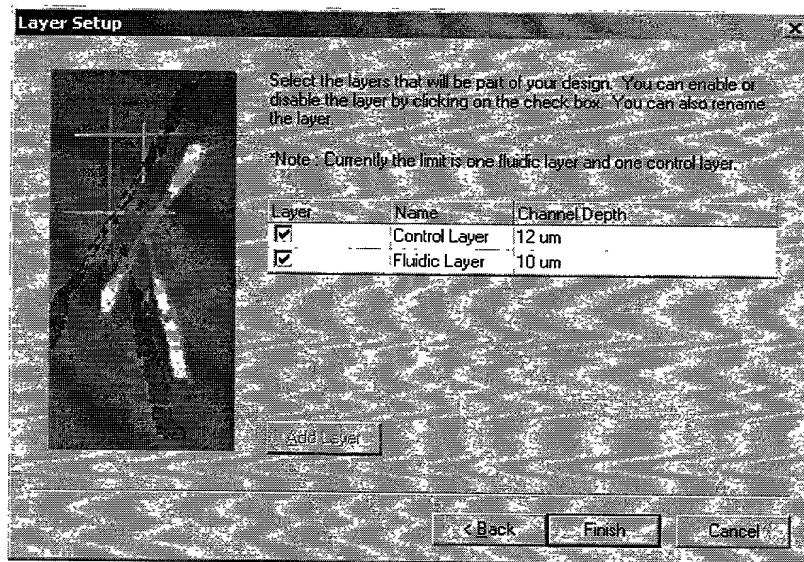


Figure 50 – Layer Selection Wizard Screen



## Placing Library Components

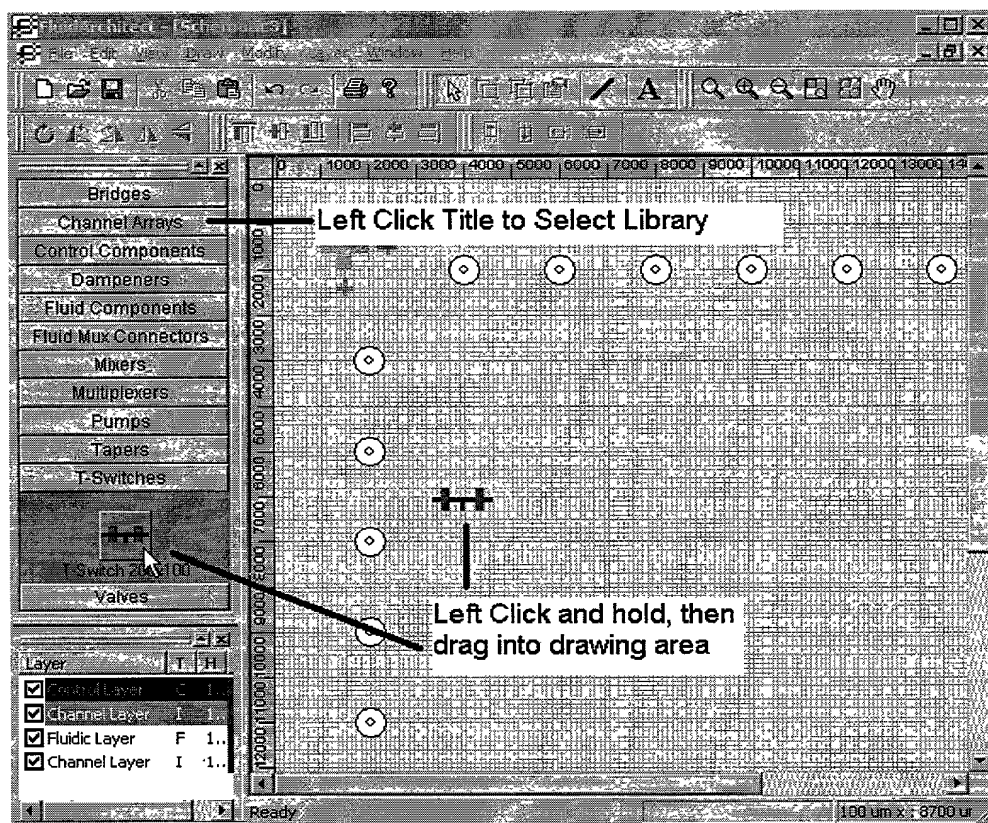


Figure 51 – Placing Components from the Libraries

The library contains a set of components that can be used in your design. Placement of the components accomplished by the following:

- Select the desired library by left clicking the mouse on the title of the library.
- Place the mouse over the desired component in the library window. The component will become selected and outlined.
- Left click and hold the mouse on the selected component and drag the component into the drawing area.
- Position the component where you would like to place it and release the left mouse button. The component will now be placed.

Figure 51 shows the process of placing the component from the library into the drawing area.

Note that the libraries provided are built specifically for use with our fabrication process. The components cannot be modified in any of its absolute dimensions. You only have control in its placement and its rotational position. If the component is rotated it should only be rotated in increments of  $\pm 90$  degrees. Rotating using the free rotation tool can cause the component to become off grid and thus prevent it from being connected to other components or channels.

Parameter	Value	Unit	Parameter	Value	Unit
Temperature	25.0	°C	Pressure	1.0	atm
Flow rate	1.0	L/min	Concentration	0.1	mol/L
Wavelength	254	nm	Path length	1.0	cm
Scan rate	10	nm/min	Resolution	0.5	nm
Integration time	1.0	s	Baseline	0.0	abs
Sample volume	10	μL	Injection volume	1.0	μL
Mobile phase	Water		Stationary phase	C18	
Column	Agilent 150	mm	Particle size	5	μm
Detector	UV-Vis		Wavelength	254	nm
Software	Agilent 1200		Version	1.0	

- Ports are shown on components as black outlined white circles.
- Ports once successfully connected they appear as black filled circles. See Figure 53.
- Zooming in can help identify the ports on components and channels.



Drawing channels to connect to other channels and components can be accomplished using the Draw Channel tool. Components are built up using channels in specific placement and physical dimensions. Thus, drawing channels to connect to components is the same as connecting to other drawn channels. The following are guidelines to keep in mind while drawing channels to make connections:

- Fluidic channels can only be connected to other fluidic channels.
- Control channels can only be connected to other control channels.
- Fluidic and Control channels cannot be drawn to overlap or cross each other.
- A 100um minimum separation between channels regardless of which layer the channels are members of.
- Only one layer can be set as “Active” so that any drawn channel is placed onto that layer.
- Widths of connecting channels must be the same.
- Channels can only be drawn orthogonally or parallel to the channel it is to be connected.

## Procedure for Drawing a Channel

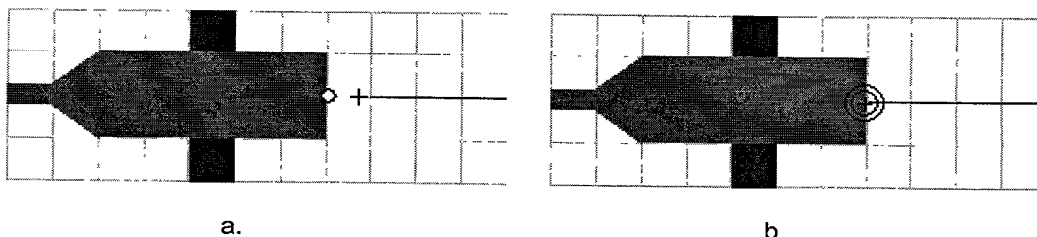
The *Channel* command under the Draw menu is used to enable the active drawing area for drawing channels. The following are the basic features to drawing channels.

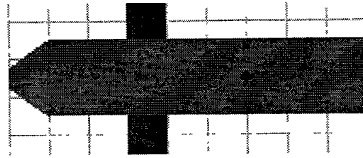
- Selecting the Draw Channel command
- Left clicking to start one end point of the channel and dragging mouse to the location of the end point and double left click to end the channel.
- Single left clicking while drawing the channel will place vertex in the channel so that you can draw orthogonally from the placed vertex.
- Right clicking while drawing a channel will cancel the channel.
- When the drawn channel is within the “auto connect” area of a port or Input/Output, the cursor becomes a target (see *Target Tool* section). Left clicking twice will cause the drawn channel to become automatically connected.

## Target Tool

Connecting channels to other channels and components is facilitated by the *Target Tool*, which is automatically engaged when drawing channels for interconnections. Figure 54 shows a channel being drawn from the right to left towards the unconnected port.

Figure 54a shows a channel being drawing towards the input of a component with the cursor identified as the “+” symbol. Figure 54b shows the cursor detecting a port on the component and changing into a “target” cursor. When the target cursor is present you can double click the left mouse button and automatically the interconnection to the port of the channel or component. The result is shown in Figure 54c. where the port has turned black indicating that the port was successfully connected.





c.

Figure 54.a Channel Port Not Detected, b. Channel Port Detected, c. Channel Connected to Port

## Input and Output Ports

The input and output ports, more commonly referred to as "I/O's", are the large circular figures on the template of the chip. Typically the I/O's are found near the perimeter of the chip. The I/O's are predetermined based on the template chosen in the Design Wizard.

I/O Ports are used to accomplish the following:

- Provide connections to fluid and material input and output from the chip.
- Provide connections to the control channels to input control signals such as air pressure.

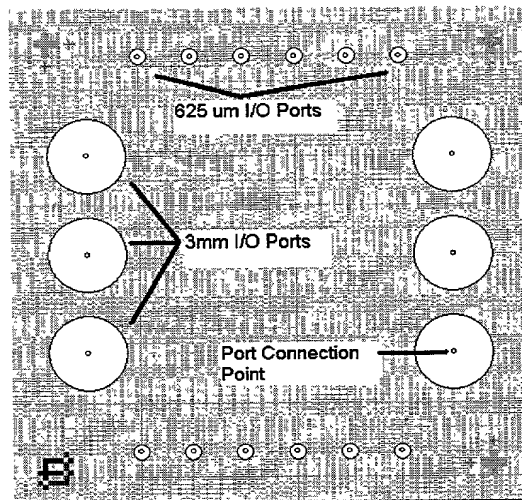


Figure 55 – Chip Template with 6 – 3mm and 12 – 625um I/O Ports

Figure 55 also shows a typical chip template with a preset I/O configuration. The connection point for each of the ports is illustrated in the figure as well. The connection point is the smaller concentric circle that is inside of the port. Connecting a channel to a port is can be accomplished by drawing a channel from a channel and when the target tool is engaged over the port, double left clicking the mouse will attach the to the I/O. Once successfully connected to the I/O, the I/O will turn blue and the inner circle will become a filled black circle. Figure 56 shows a connected I/O.

## Channel Properties

- Change Channel Instance Names
- Change Channel Widths (Fluidic and Control)
- List the connections to other components or channels

Figure 57 shows the channel dialog box for a selected control channel. You can change the width to any value in the drop down box as well as assign a new name to the channel. The channel is not currently connected to any other channel or component so the *Connections* list is empty.





Figure 59 – Component Instance Property Dialog Box

## Design Example

In the following design example a simple cell sorter, shown in Figure 60, is created using FluidArchitect. The pump drives into a T-Switch. The T-Switch is used to drive the fluid/material flow into one of two ports based on the detection region feedback to a system, which monitors and controls the flow. The design will illustrate the methods and procedures used to create the design in FluidArchitect.

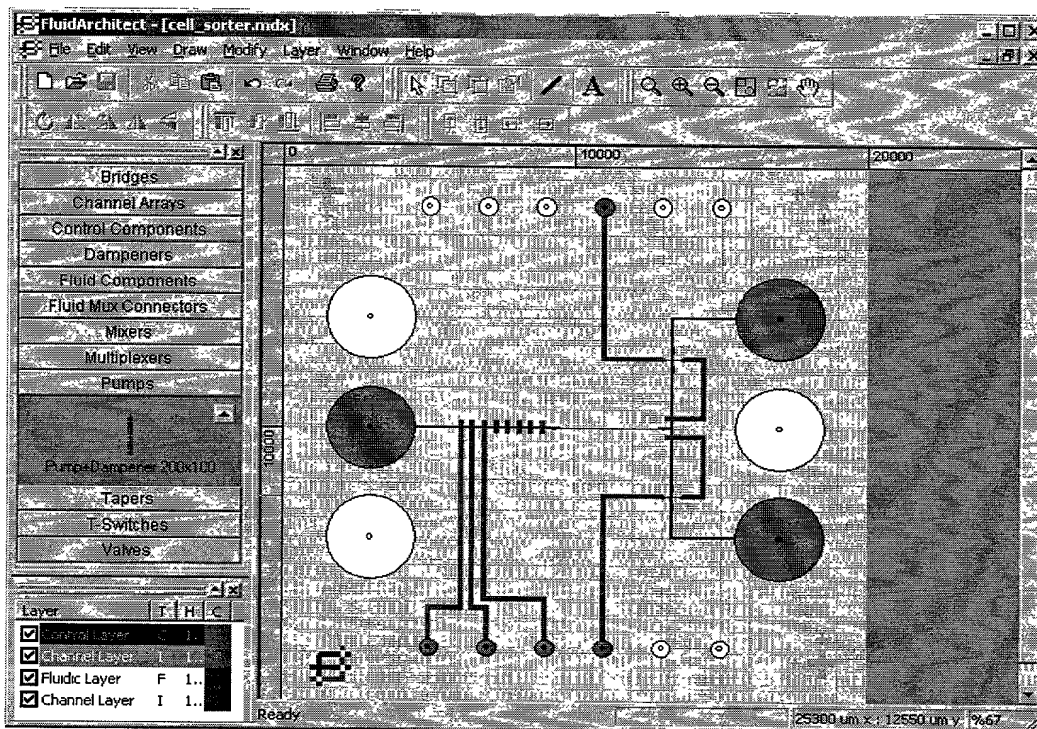


Figure 60 – Completed Design of the Simple Cell Sorter

## Components Required

The components required to construct the simple cell sorter are:

- 1 - Peristaltic Pump
- 1 - T-Sorter
- 2 – 30 um–100 um Fluidic Tapers
- 2 – Bridges
- 3 – 3 mm I/O Ports
- 5 – 625 um I/O Ports

## Basic Operation of the Design

Figure 61 shows the pump, T-Sorter, and the bridges connected in the drawing area. There are many ways to connect the components together and if the design rules are not violated the design will be valid.

Figure 61 also points out a “Detection Region”. This region can be used by an optical detection system to control the direction of the flow through the T-Sorter. The detection region is not a component from the library but rather a user drawn 30 um fluidic channel connecting fluidic taper components forming the region.

Cells are pumped through the channel from the 3mm input port on the left side of the chip using the three control valves and five damping elements that constitutes the pump. An



external detection system, such as an optical measuring system, detects cells as they flow through the "Detection Region". The cells can be directed in either direction to the 3mm output ports by actuation of the T-sorter valve switches. The Bridge components are used to enable the crossing of fluid lines by control lines without creating a parasitic valve. The Bridge components were used in this design to create an area clear of channels for the "Detection Region".

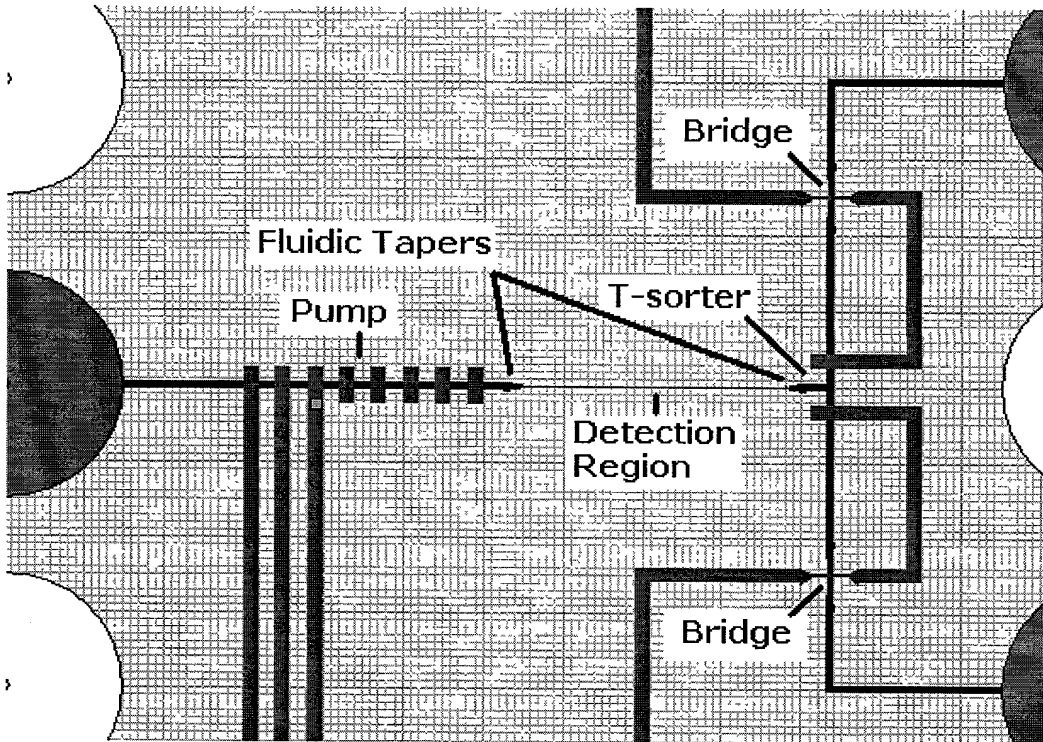


Figure 61 – Components of the Simple Cell Sorter

## Creating the Design

Start the design by launching FluidArchitect from the *Start* menu > *FluidArchitect* > *FluidArchitect* on your PC.

Once the FluidArchitect is started, the next step is to select *File* menu > *New*. The design wizard will start and guide you through the setup for a new design.

## Design Wizard Setup

The Figure 62 shows the Design Wizard screens as they appear in order querying for selections. Carefully read the screens shown by the Design Wizard to appropriately setup the design. Failure to setup the design correctly could lead to reiterations of the design to get the desired results.

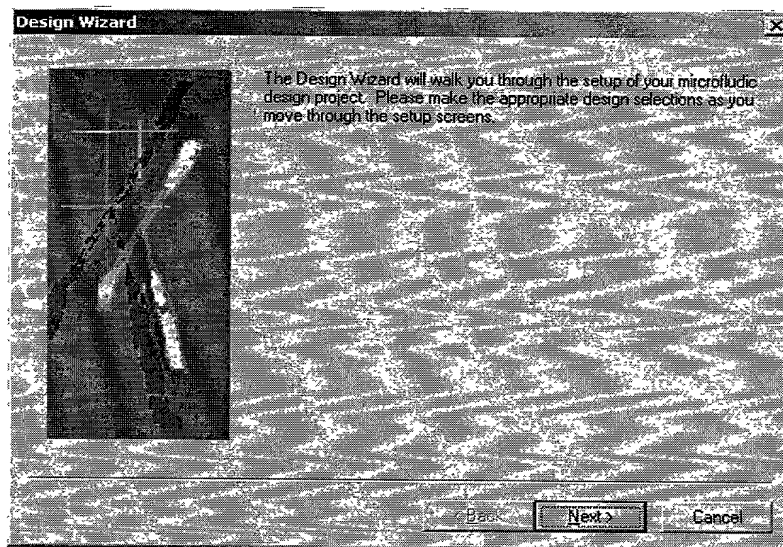


Figure 62 – First Design Wizard Screen

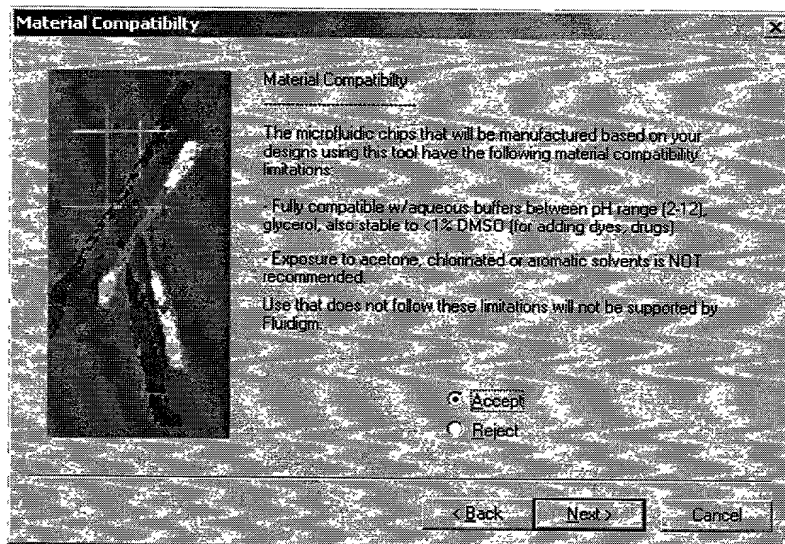


Figure 63 – Material Compatibility Design Wizard Screen

The material compatibility screen warns you to the materials that can and cannot be used with the microfluidic chips that are designed with the FluidArchitect system and fabricated by Fluidigm. Selecting "Accept" will allow you move forward with the design setup. If your needs are not met and you "Reject" the Design Wizard will not go forward. Please contact the factory for more details regarding your special needs.

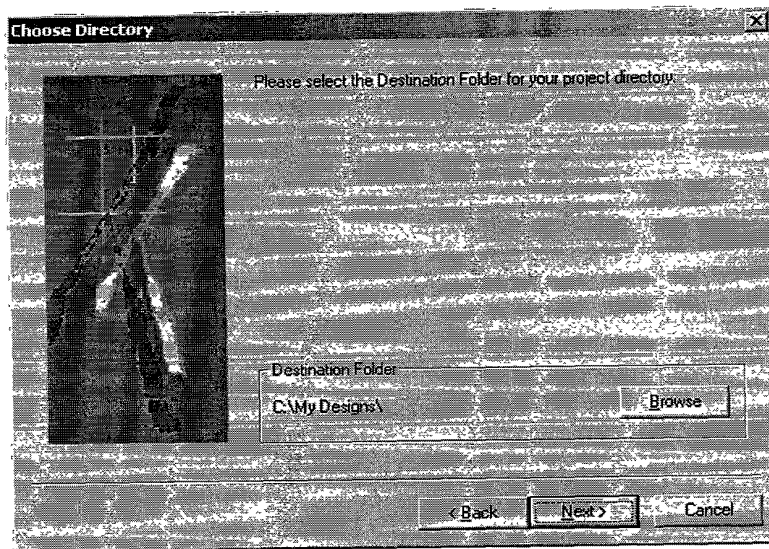


Figure 64 – Project Directory Selection

The Project Directory selection screen simply selects the directory where your design database will be stored.

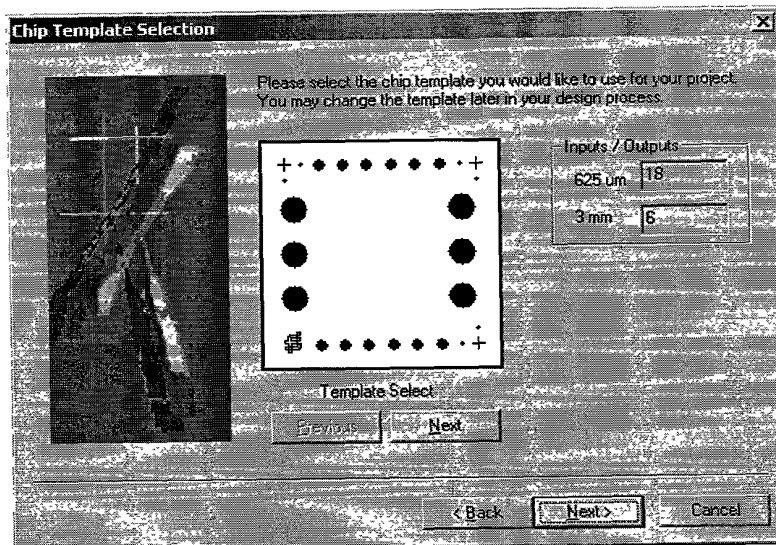


Figure 65 – Chip Template Selection

The chip template selection is very important. Please consider your design and how many inputs and outputs are needed. There are several templates to choose from and the number of 625 um and 3 mm input/output ports are shown in the page as you select the template need. Currently it is not possible to change chip templates in the middle of a design.

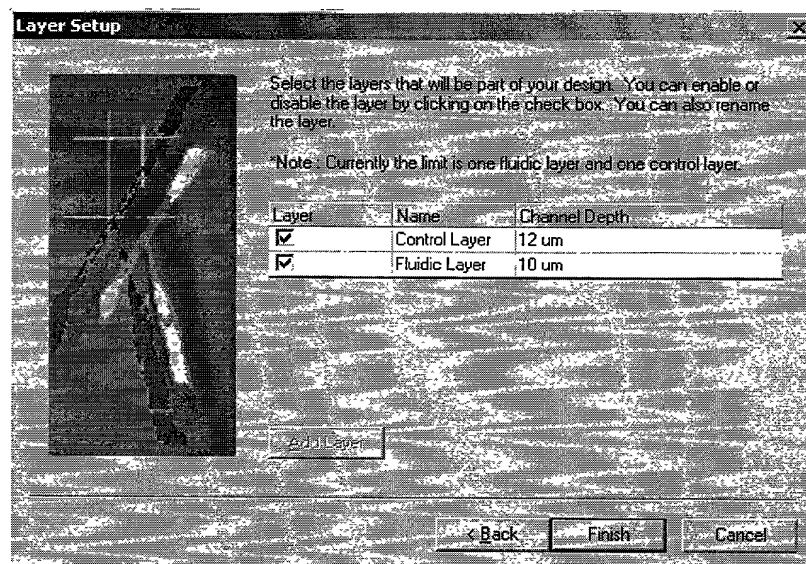


Figure 66 – Layer Setup

The layer setup page allows you to select the layers needed in your design. By default two layers are selected and this is necessary to create active fluidic circuits on the chip. Currently the system is restricted to having a maximum of two layers. Each layer has a channel depth associated with the layer that is fixed in depth.

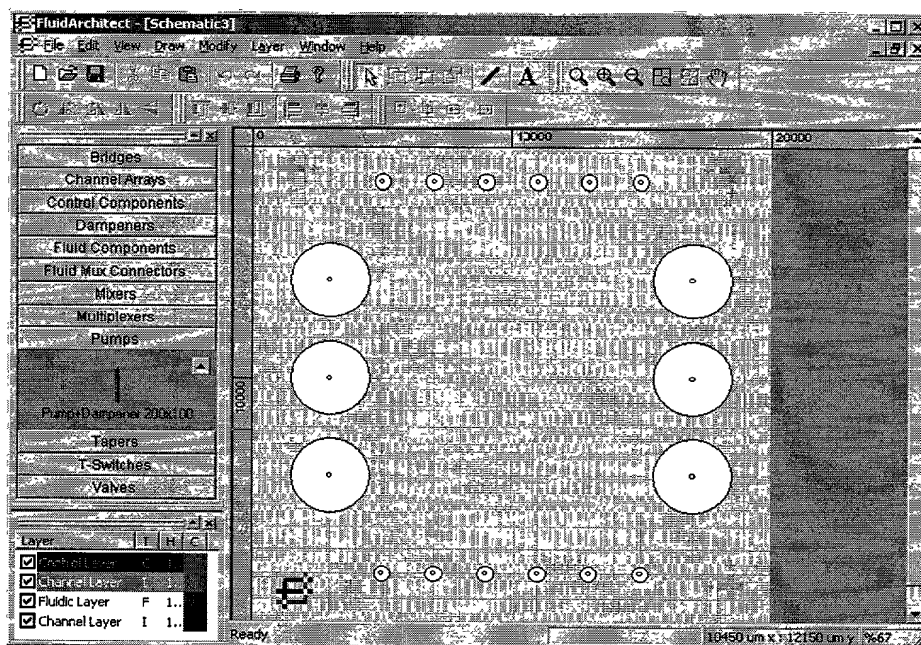


Figure 67 – Completed Design Wizard Setup View

Once you have completed the Design Wizard the chip template chosen will appear in the drawing area as shown in Figure 67. The library components are ready for selection and placement into your design. The layer manager indicates the color of the channels and two which layer they belong as well as the current "Active" layer which is highlighted in black.

## Placing Components

Simply select the library from which to drag and drop the components and place them into the drawing area. Left click on the T-Switches title bar in the Library Manager to select the library. Figure 68 shows the T-Switch library being selected and the T-Switch being placed into the drawing area. As the T-Switch is being dragged and positioned it appears as outline of dashed lines. Once placed

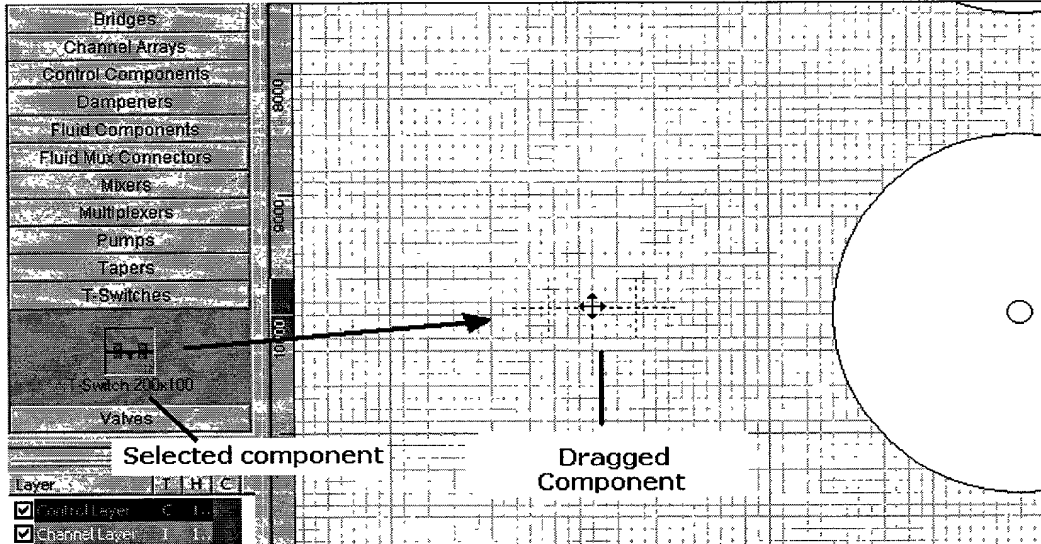


Figure 68 – Placing the T-Switch Component

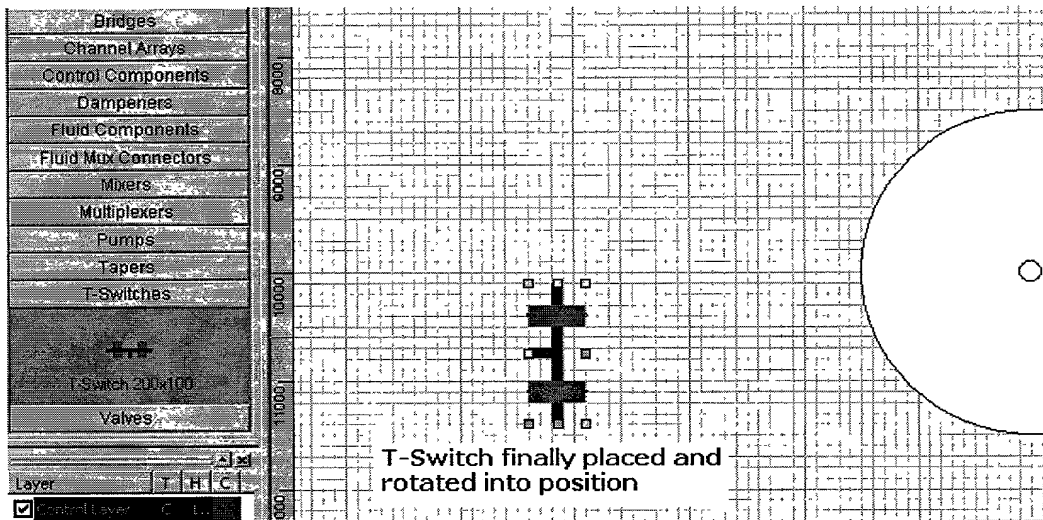


Figure 69 – Finally Placed T-Switch

The placed T-Switch component can now be selected by left clicking it. Once selected, it can be rotated or positioned depending on what is required.

Now, the steps above should be repeated to place the rest of the components for this design.

## Connecting the Components

Once all of the components are placed, they must be connected. The components typically consist of channels from both the fluidic and control layers that are specifically positioned and dimensioned to insure proper operation.

Figure 70 shows the connection of the T-Switch to the “Detection Region”, which consists two taper elements and a 30  $\mu$ m channel connecting between the two tapers. Recall that to select a component that only has channel in either the fluidic or control layer, the fluidic or control layer must be set “Active”. This can be done in the Layer Manager by left clicking on the desired layer and right clicking to bring up the pop up menu to set the layer “Active” OR this can also be done by right clicking in the drawing area and bring up the pop up menu and selecting *Layer > Control* or *Fluidic*.

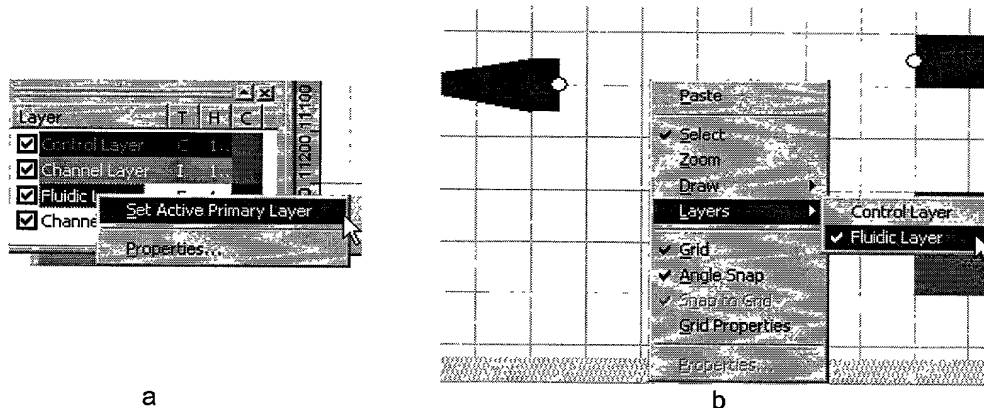


Figure 70. a. Selecting the “Active” Layer through the Layer Manager, b. Selecting the “Active Layer” through the right clicked pop up menu in the drawing area.

In this case the Fluidic Layer needed to be selected as the 30  $\mu$ m – 100  $\mu$ m Taper component was being connected to the input of the T-Switch. Figure 71 shows a channel being drawn from the right end of the Taper component to the input of the T-Switch. Once the cursor turns into the Target Tool a left click will cause a channel to be connected to the unconnected port.

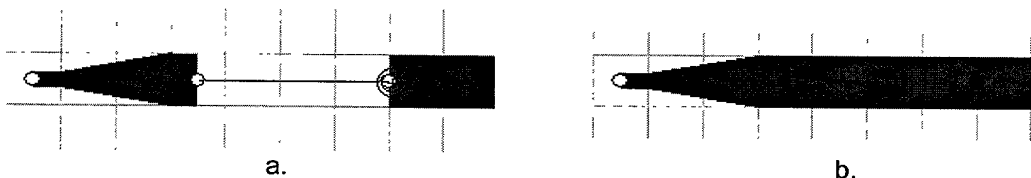


Figure 71 – a. Drawing a Fluidic Connecting Channel, b. Successfully Connected Channel.

## Adding a Vertex While Drawing a Channel

While you are drawing a channel, you can single left click to place a vertex from which you can continue to draw a straight channel or draw the channel orthogonally from the placed vertex. Figure 72 shows an example of how to place a vertex and draw a channel with an orthogonal continuation.



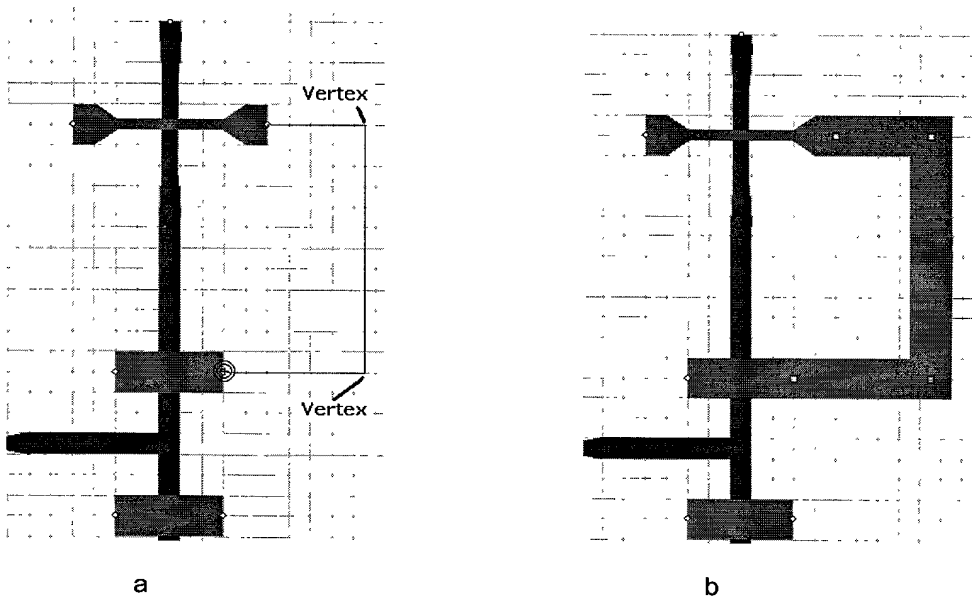


Figure 72 – a. Drawing the control channel and placing the two vertices as shown. b. Completing the connection and the control channel.

## Changing the Channel Widths

The width of the drawn fluidic channel was set to 100  $\mu\text{m}$  as the default. The default setting for a new design is 100  $\mu\text{m}$  for a user drawn fluidic channel and 200  $\mu\text{m}$  for a user drawn control channel. FluidArchitect will keep the default width setting until the user changes the channel width through selecting a channel and changing its width. Figure 73 shows the how the drawn fluidic channel is originally drawn as 100  $\mu\text{m}$  but needs to be resized to match the components that it connects to.

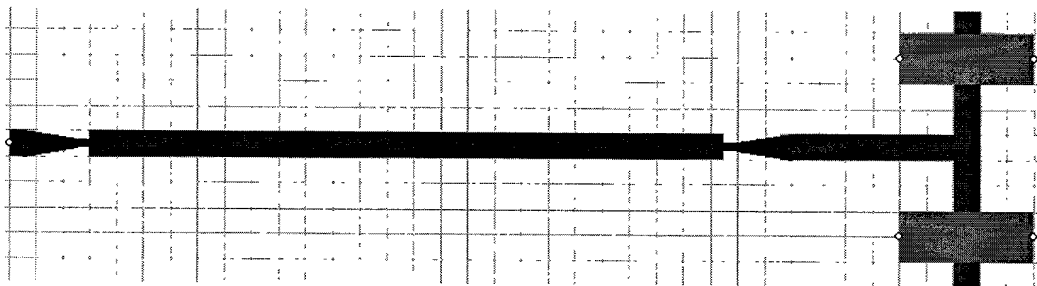


Figure 73 – Drawn Channel Not the Correct Width for Connection

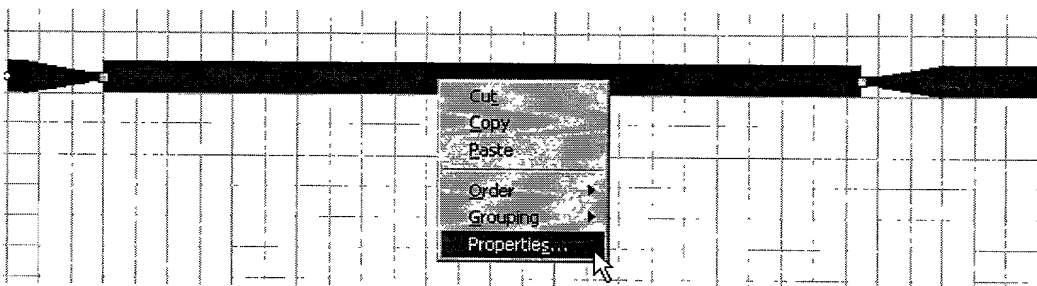


Figure 74 – Open the Channel Properties Dialog to Set Correct Channel Width

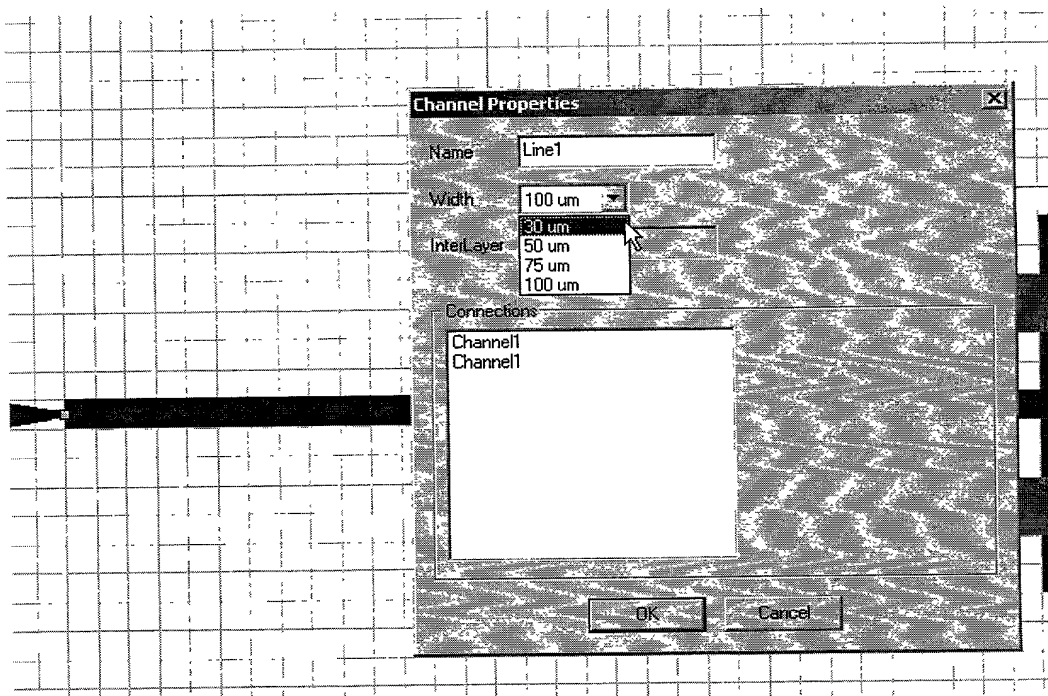


Figure 75 – Setting the Channel Width

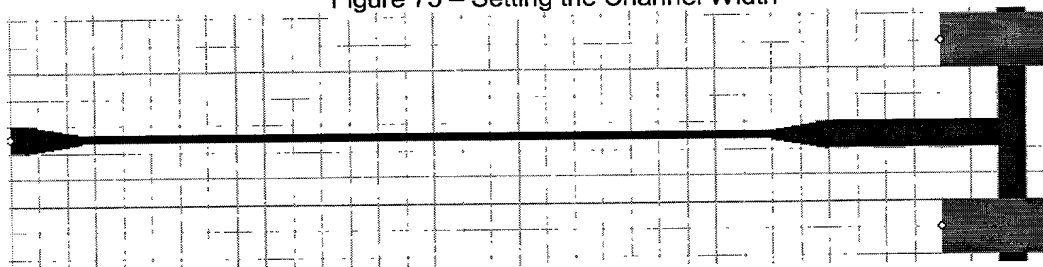


Figure 76 – Drawn Fluidic Channel Width is Now Correct

## Connecting To I/O Ports

Once all of the components have been interconnected, the inputs and outputs (I/O) need to be connected. They are connected much in the same way that channels are connected with the help of the Target tool. Once the I/O's are successfully connected, the outlined ports will turn from white to black and the port will turn blue as well. Figure 77 shows an example of a successfully connected 625 um port.



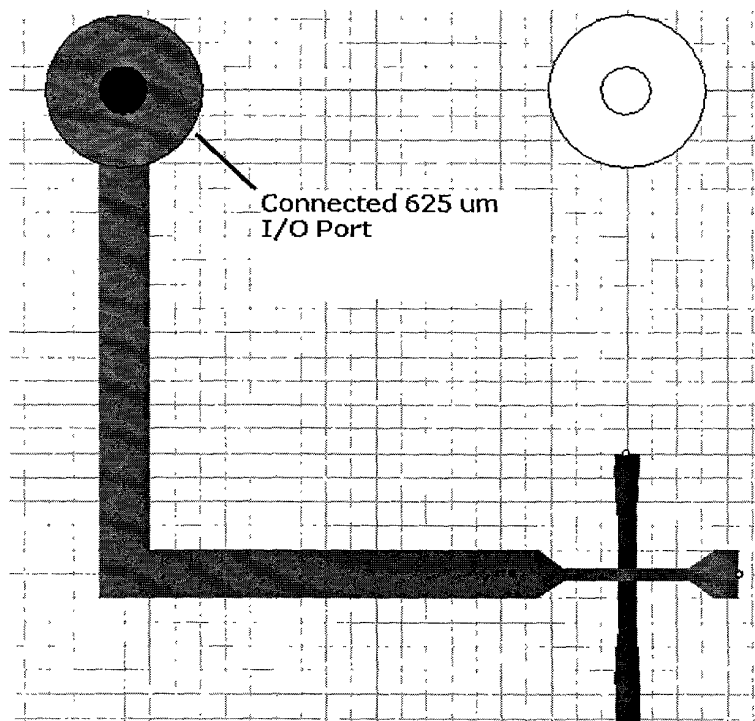
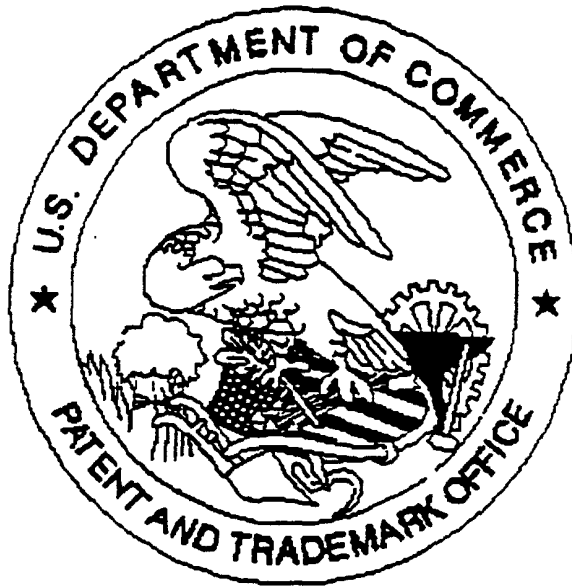


Figure 77 – Bridge Component Connected to an I/O Port

## Conclusion

Using the techniques in the example design give above will help lead to successful microfluidic chip design using FluidArchitect. Recall, there are built in design rule checkers that will give you warnings and errors from time to time as you are designing based on what you are connecting and drawing.

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